PM

29 DEC 1967

T.O. 33A1-13-8-2

HANDBOOK
SERVICE INSTRUCTIONS

SPECTRUM ANALYZER
AN/UPM-17

(LAVOIE LABORATORIES)

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Page No.	Change No.	Page No.	Change No.	Page No.	Change No.
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*A	1				
i – iv	0				
1 – 45	0				
*46	1				
47 – 53	0				
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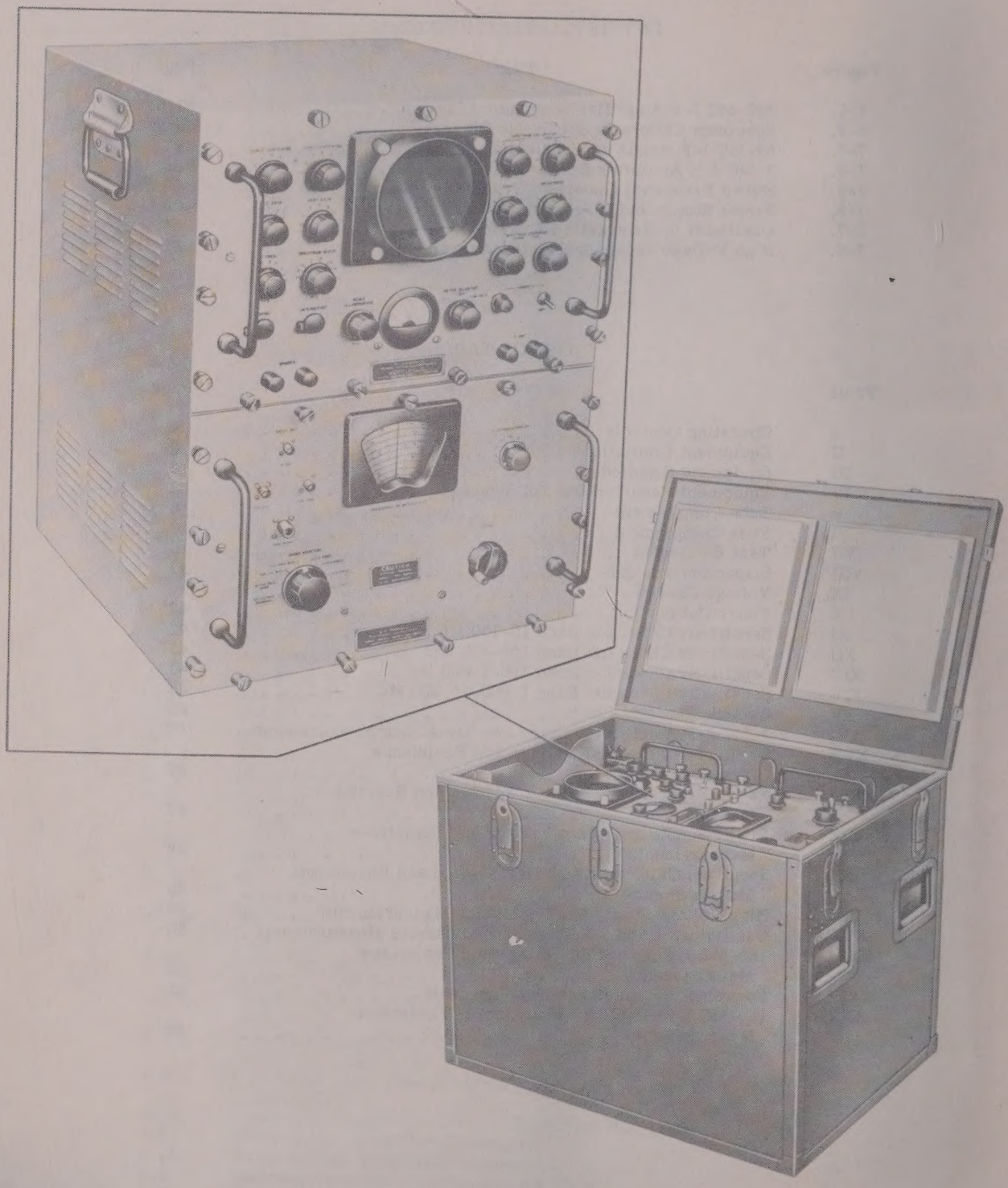


Figure 1-1. Spectrum Analyzer AN/UPM-17

INTRODUCTION

This handbook is intended for the use of the technician concerned with the maintenance of the Spectrum Analyzer AN/UPM-17. The handbook contains information on theory of operation, and organizational and field maintenance of the analyzer.

SECTION I

GENERAL DESCRIPTION

1-1. PURPOSE OF HANDBOOK.

1-2. This publication comprises service instructions for the Spectrum Analyzer AN/UPM-17 (figure 1-1), manufactured by Lavoie Laboratories, Incorporated, Morganville, New Jersey.

1-3. SCOPE OF HANDBOOK.

1-4. Sections I through VII of this handbook apply to the Spectrum Analyzer AN/UPM-17, manufactured under Contract No. AF33(604)-7606. Additional models will be covered in Section VIII by the use of Difference Data Sheets. Service instructions for models included in Section VIII are the same as the procedures given in Sections I through VII, except for the specific differences noted by the applicable Difference Data Sheets.

1-5. PURPOSE AND BASIC PRINCIPLES OF THE EQUIPMENT.

1-6. The spectrum analyzer is an electronic test instrument used to analyze the frequency spectrum and pulse shape of pulsed r-f oscillators employed in radar transmitters. The instrument can be used to check frequency modulation and frequency stability of the r-f oscillator as well as to measure the pulse width and bandwidth of the r-f oscillator pulse. The analysis of pulse shapes is accomplished by viewing the pattern on the cathode-ray tube screen of the analyzer. The pulse pattern represents the distribution in frequency of the r-f power of the pulse.

1-7. The spectrum analyzer is an instrument that incorporates a narrow-band superheterodyne receiver which is physically divided into two major components: the Pulse Analyzer Indicator IP-130/UPM-17 and the R-F Tuner TN-188/UPM. The Pulse Analyzer Indicator IP-130/UPM-17 is actually a complete spectrum analyzer which covers a frequency range from 145 to 175 MC. When the input frequency is 160 MC, and the spectrum width is set at 10 MC, this unit possesses a sensitivity of approximately ten microvolts for a signal-to-noise ratio of two to one. The R-F Tuner TN-188/UPM is primarily a frequency converter which changes the frequency range of 10 to 16,000 MC into a basic frequency range of 145 to 175 MC. The converted signal from the tuner unit is fed to the indicator unit where it appears as a vertical signal on the baseline of the KRT. This baseline represents a frequency domain. The converted signal is that which is viewed (vertically) on the cathode-ray tube screen on the panel of the indicator unit. The scope pattern produced is a plot indicating power vertically and frequency horizontally, and represents the spectrum of an input signal to the spectrum analyzer.

1-8. To visually display the desired spectrum, the second local oscillator of the analyzer is swept in frequency while the horizontal deflection of the scope is

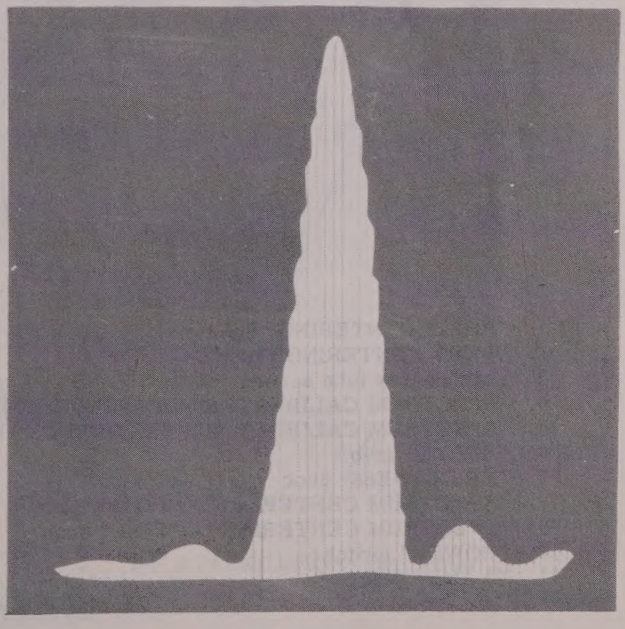
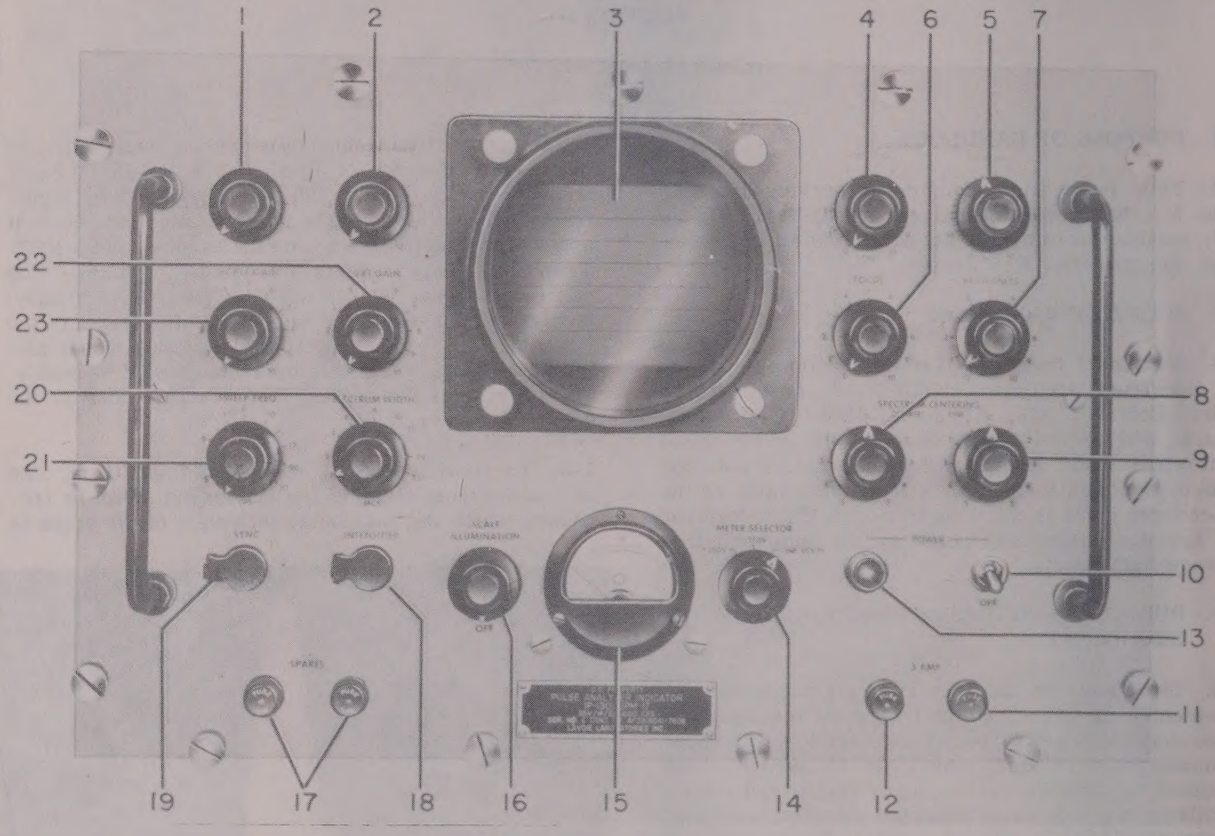


Figure 1-2. Typical Rectangular R-F Pulse Analyzed on Spectrum Analyzer AN/UPM-17

varied in synchronism. For a pulsed input signal, a succession of transients appears on the screen which resemble a picket fence, and the envelope of the transients is proportional to the power spectrum. For ranges of frequency of the order of 0.5 to 25 MC, the horizontal deflection is accurately proportional to frequency. Figure 1-2 illustrates a one-microsecond rectangular pulse, having negligible frequency modulation, as it appears on the screen of the cathode-ray tube. The illustration reveals the individual transients composing the spectrum.

1-9. DESCRIPTION OF UNITS.

1-10. GENERAL. The spectrum analyzer is designed to operate from a 115-volt, 50-1000 cps power supply. The power consumption is 250 watts, maximum. The instrument is capable of operating in the range of 10 to 16,000 MC. All frequencies are read on one direct-reading illuminated dial with an accuracy of plus or minus one percent. The pulse is analyzed on a five-inch cathode-ray tube. Conventional oscilloscope controls are included to adjust the image for proper analysis. The spectrum width of pulse can be made to represent a frequency width from 1/2 to 25 MC. A variable amplitude spectrum calibrator (frequency-marker oscillator), with a flat output and a frequency range of plus and minus 15 MC, is provided. The entire instrument is contained in two sliding-drawer units. The two units comprising the analyzer instrument are the Pulse Analyzer Indicator IP-130/UPM-17 and the R-F Tuner TN-188/UPM. A transit case is supplied for storage and shipment of the instrument.



1. "HORIZ CENTERING" knob
2. "VERT CENTERING" knob
3. Cathode-ray tube screen
4. "SPECTRUM CALIBRATOR"-"AMPLITUDE" knob
5. "SPECTRUM CALIBRATOR"-"FREQUENCY" knob
6. "FOCUS" knob
7. "BRIGHTNESS" knob
8. "SPECTRUM CENTERING" - "COASE" knob
9. "SPECTRUM CENTERING" - "FINE" knob
10. "POWER" switch
11. "3 AMP" fuse
12. "3 AMP" fuse
13. "POWER" indicator lamp
14. "METER SELECTOR" switch
15. Voltmeter indicator
16. "SCALE ILLUMINATION" knob
17. "SPARES" (fuses)
18. "INTENSIFIER" adjustment control
19. "SYNC" adjustment control
20. "SPECTRUM WIDTH" knob
21. "SWEEP FREQ" knob
22. "VERT GAIN" knob
23. "HORIZ GAIN" knob

Figure 1-3. Pulse Analyzer Indicator IP-130/UPM-17, Front Panel View

Cable assemblies and two variable r-f attenuators are also supplied and are located on the interior of the transit case.

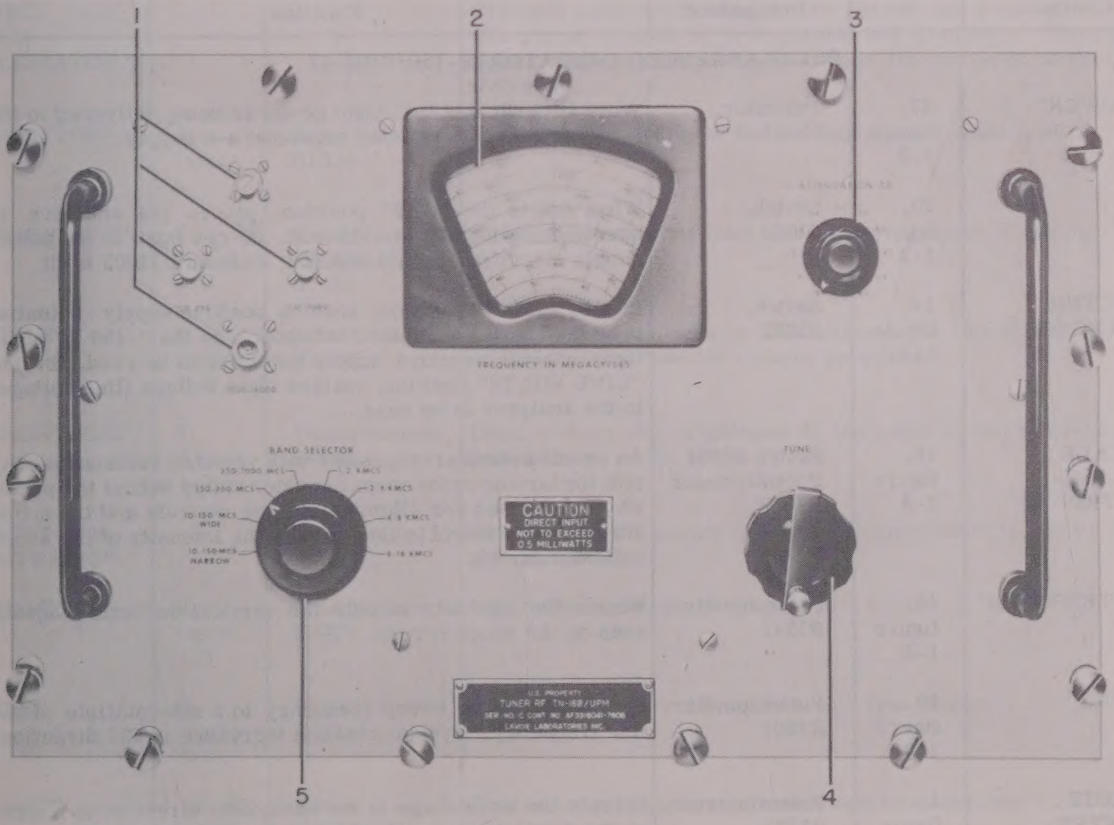
1-11. PULSE ANALYZER INDICATOR IP-130/UPM-17.

NOTE

All panel controls referred to in this handbook are spelled exactly as marked on the equipment.

1-12. Shown in figure 1-3 is a front panel view revealing the location of all operating and adjustment controls on the pulse analyzer indicator unit, which constitutes the upper half of the analyzer instrument. Table I, Operating Controls, describes the function and lists the type and designation of each control. The indicator unit panel primarily consists of a five-inch cathode-ray tube, type 5CP1A, and associated controls to aid in adjusting the various wave shapes viewed for proper analysis. The controls used to accomplish this purpose are "HORIZ CENTERING," "VERT CENTERING," "HORIZ GAIN," "VERT GAIN," "SWEEP FREQ," "SPECTRUM WIDTH," "SPECTRUM CALIBRATOR," "FOCUS," "BRIGHTNESS," "SPECTRUM CENTERING," "SYNC," and "INTENSIFIER". A voltmeter is included on the panel for indicating either the line voltage (115 volts input), i-f amplifier plate voltage, or negative supply potential. The voltages to be read are selectable by use of the "METER SELECTOR" knob. An on-off switch is located on the panel for starting the equipment in operation. Two "3 AMP" input-power fuses are mounted on the panel and can be easily removed and replaced, if defective. Two spare fuses are provided for maintenance purposes. The two covered screw - driver - adjustment potentiometers "SYNC" and "INTENSIFIER" are included for conveniently synchronizing the sweep frequency, and to vary the average intensity of the vertical deflection signals on the scope, respectively,

1-13. The interior of the indicator unit primarily consists of a sweep frequency generator strip, spectrum calibrator, two i-f amplifier strips (1 mc and 64 mc), low-voltage power supply sweep and video, and a high-voltage power supply. Two interior indicator lamps, placed on both sides of the scope screen, provide illumination for the markings on the reticule (the plexiglass assembly mounted in front of the KRT face). The



1. "INPUT-MCS" cable receptacles
2. "FREQUENCY IN MEGACYCLES" dial
3. "I-F ATTENUATION - DB" knob
4. "TUNE" knob
5. "BAND SELECTOR" knob

Figure 1-4. R-F Tuner TN-188/UPM, Front Panel View

intensity of the two indicator lamps is varied by rotating the "SCALE ILLUMINATION" control on the front panel of the indicator unit.

1-14. R-F TUNER TN-188/UPM.

1-15. Shown in figure 1-4 is a front panel view revealing the location of all operating controls on the r-f tuner unit, which constitutes the lower half of the analyzer unit. Table I, Operating Controls, describes the function and lists the type and designation of each control. The r-f tuned unit panel consists of a direct-reading illuminated dial, "FREQUENCY IN MEGACYCLES," which displays the frequency of the local oscillator located in the tuner unit. The frequency of the oscillator is adjusted by the "TUNE" control, and as the "TUNE" knob is varied the dial rotates to indicate the frequency to which the input is tuned. The band of frequencies to be read on the dial is selectable by use of a seven-position "BAND SELECTOR" switch which enables the entire range of frequencies from 10 to 16,000 MC to be tuned. Four input receptacles "INPUT MCS" are included on the panel for connecting the analyzer to the radar equipment to be tested. To check the specified range of frequencies desired (10-150, 150-350, 350-1000, or 1000-16,000 MC), the appropriate input receptacle must be used. In conjunction with this, the "BAND SELECTOR" knob must be placed on the corresponding frequency range labeled on the panel.

1-16. The interior of the r-f tuner unit primarily consists of three oscillators, oscillators 1 and 2, oscillator 3, and oscillator 4, along with the i-f amplifier strip (160 mc). Also included is a gear train assembly, which is connected to the "TUNE" control, the "FREQUENCY IN MEGACYCLES" dial, and to the three oscillator assemblies. Thus, during tuning operation, as the "TUNE" control is manipulated, the frequency dial rotates simultaneously with the variable elements in the local oscillators.

TABLE I. OPERATING CONTROLS

Control	Figure and Index No.	Type and Designation	Function
PULSE ANALYZER INDICATOR IP-130/UPM-17			
"POWER"	13, figure 1-3	Indicator, I1003	When lit, indicates that input power is being delivered to the analyzer from an external source of a-c supply.
	10, figure 1-3	Switch, S1003	When not in the "OFF" position, places the analyzer in operation by feeding the 115-volt, 60-cps input to the power supply circuitry. In this position, indicator I1003 is lit.
"METER SELECTOR"	14, figure 1-3	Switch, S1002	In the "+150 V" position, enables positive supply potential to be read on the voltmeter indicator. In the "-150 V" position, enables negative supply potential to be read. In the "LINE VOLTS" position, enables input voltage (line voltage) to the analyzer to be read.
"SCALE ILLUMINATION"	16, figure 1-3	Switch S1001 Potentiometer R1003	An on-off switch arrangement with variable resistance control for turning on the scope indicator lamps behind the panel, which are used for illuminating the reticule and the scope screen. The control is used to vary the intensity of the scope indicator lamps.
"INTENSIFIER"	18, figure 1-3	Potentiometer, R1341	Varies the intensity of only the vertical deflection signals seen on the scope screen.
"SYNC"	19, figure 1-3	Potentiometer, R1301	Synchronizes the sweep frequency to a sub-multiple of the line frequency. Synchronization increases in CW direction.
"HORIZ CENTERING"	1, figure 1-3	Potentiometer, R1323	Directs the wave shape in the horizontal direction of X axis on the scope screen. Used to horizontally center the image viewed on the scope.
"VERT CENTERING"	2, figure 1-3	Potentiometer, R1336	Directs the wave shape in the vertical direction or Y axis on the scope screen. Used to vertically position the image viewed on the scope.

TABLE I. OPERATING CONTROLS (cont)

Control	Figure and Index No.	Type and Designation	Function
PULSE ANALYZER INDICATOR IP-130/UPM-17			
"HORIZ GAIN"	23, figure 1-3	Potentiometer, R1317	Narrows or broadens the baseline and image or wave shape viewed on the scope screen to the width of the reticule.
"VERT GAIN"	22, figure 1-3	Potentiometer, R1325	Increases or decreases the amplitude of the image viewed on the scope screen. (Do not operate below 1-1/2 divisions to avoid saturation of square law detector.)
"SWEEP FREQ"	21, figure 1-3	Potentiometer, R1307B	Controls the frequency of the sweep as displayed on the scope.
"SPEC-TRUM WIDTH"	20, figure 1-3	Potentiometer, R1314	Calibrates the entire width of the reticule (10 cm. wide) on the scope screen to represent a bandwidth of 1/2 to 25-mc. When analyzing frequencies below 50 mc, and the "BAND SELECTOR" switch is on "NARROW," this control should be limited to a value below the frequency being analyzed.
"SPEC-TRUM CALIBRATOR"			Presents a pip which acts as a marker on the scope screen. The pip is adjustable in amplitude and frequency. The pip allows frequency measurements of the 160-mc i-f to be made with ease.
"AMPLITUDE"	4, figure 1-3	Potentiometer, R1014	Varies the amplitude of the marker pip and shuts it off.
"FREQUENCY"	5, figure 1-3	Variable Capacitor C1403	Varies the frequency (and, therefore, position) of the pip.
"FOCUS"	6, figure 1-3	Potentiometer, R1006	Controls the sharpness or distinction of the image displayed on the scope screen for viewing purposes.
"BRIGHTNESS"	7, figure 1-3	Potentiometer, R1004	Used to vary the brightness of the pulse or any deflection pattern seen on the scope.
"SPECTRUM CENTERING"			Changes the frequency spectrum electronically to center of the reticule.
"COARSE"	8, figure 1-3	Potentiometer, R1017	Varies the spectrum frequency in a coarse manner.
"FINE"	9, figure 1-3	Potentiometer, R1018	Varies the spectrum frequency in a fine manner.
"3 AMP"	11, 12 figure 1-3	Fuses, F1001, F1002	Protects the analyzer instrument against overload.
"SPARES"	17, figure 1-3	Spare Fuses, F1001, F1002	Spare fuses to be used if the "3 AMP" fuses become defective.

TABLE I. OPERATING CONTROLS (cont)

Control	Figure and Index No.	Type and Designation	Function
R-F TUNER UNIT TN-188/UPM			
"FREQUENCY IN MEGACYCLES"	2, figure 1-4	Dial mechanically connected to the shaft of the "TUNE" control	Indicates frequency of signal to which analyzer is tuned. Dial rotates as "TUNE" control is varied clockwise or counterclockwise.
"TUNE"	4, figure 1-4	Knob connected by gearing to variable capacitors C2502 and C2515 in local oscillator	Use to adjust the frequency of the signal to which analyzer is tuned. By rotating the "TUNE" control capacitors, C2502 and C2515 vary to change the oscillator frequency.
"BAND SELECTOR"	5, figure 1-4	Selector Switch, S2001	Used to select the frequency band desired for analyzing.
"INPUT MCS"	1, figure 1-4	Receptacles	Signal input receptacles used for connecting the analyzer instrument to the equipment to be tested.
"10-150"		J2004	Input receptacle used for analyzing frequencies between 10 and 150-mc.
"150-350"		J2005	Input receptacle used for analyzing frequencies between 150 and 350-mc.
"350-1000"		J2006	Input receptacle used for analyzing frequencies between 350 and 1000-mc.
"1000-16,000"		J2007	Input receptacle used for analyzing frequencies between 1000 and 16,000-mc.
"IF ATTENUATION DB"	3, figure 1-4	Selector Switch, S2002	Controls attenuation of output of 160-mc i-f amplifier.

1-17. VARIABLE R-F ATTENUATORS. Two variable r-f attenuators are supplied and used: the Variable R-F Attenuator CN-319/UPM-17 and the Variable R-F Attenuator CN-211/U (see figure 1-5). The former covers a frequency range of 1 to 4 kilomegacycles, while the latter covers a range from 4 to 12.4 kilomegacycles. Both attenuators are of the waveguide-below-cutoff type and operate in the TE $_{1,1}$ mode (inductive coupling). The R-F Attenuator CN-319/UPM-17 contains a 50-ohm termination. The output impedance of the attenuator is varied by rotating the calibrated micrometer adjustment. Each revolution of the micrometer barrel changes the attenuation 20 db, the range of the readings being from -9 db to 140 db. R-F Attenuator CN-211/U micrometer adjustment contains two major divisions marked 50 and 100, and 25 sub-divisions, each corresponding to a change of five points on the scale. Each revolution of the micrometer barrel changes the scale setting by one sub-division, corresponding to an attenuation of approximately 11 db (at 9430 mcs).

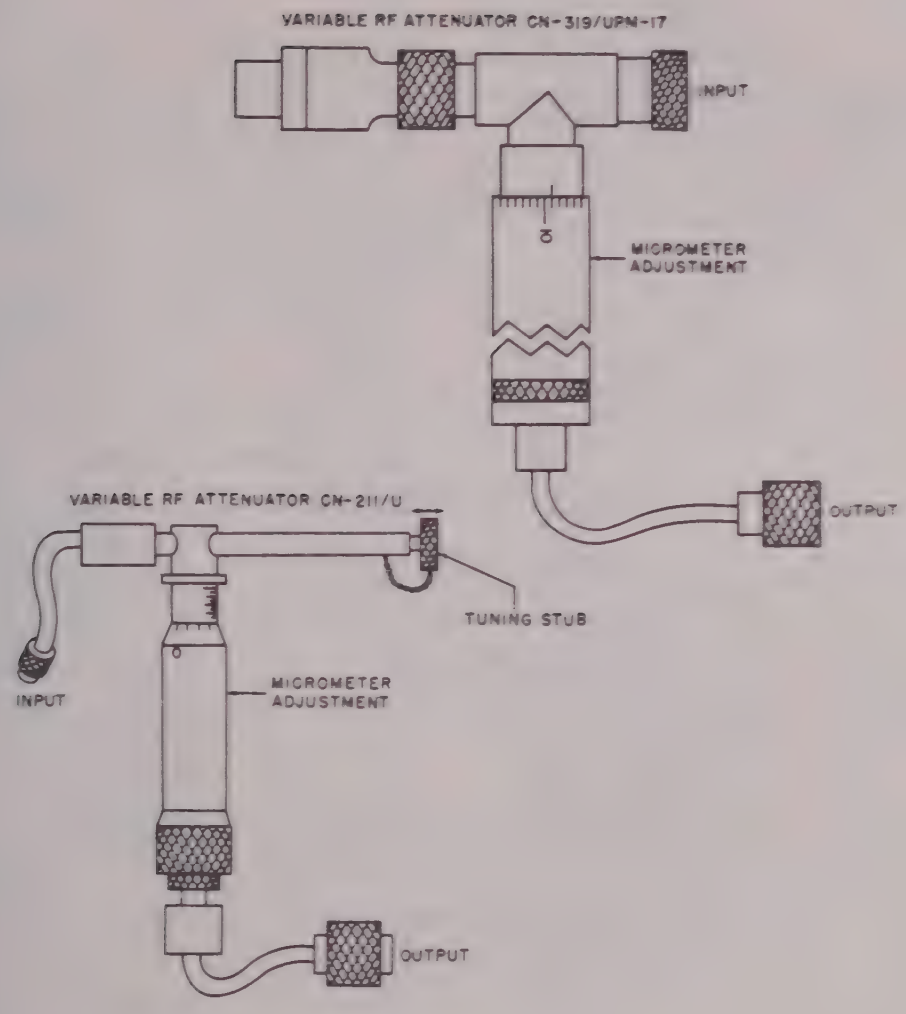


Figure 1-5. Variable R-F Attenuators

1-18. SUPPLEMENTARY DATA.

1-19. Supplementary data on the Spectrum Analyzer AN/UPM-17 is given in Tables II, III, IV, V and VI. Table II, Equipment Limitations, lists the operating characteristics of the test instrument. Table III, Equipment Supplied, lists the components supplied to the operating activity as part of the analyzer equipment. Table IV, Equipment Required But Not Supplied, lists the components not supplied but which are required by the operating activity to operate the analyzer. Each tabulated item indicates the quantity required for a typical installation, the short form name, and Government type designation. Table V, Tube Complement, lists all the tubes and crystals used, by component, along with the quantity, JAN type number and functions of each. Table VI, Fuse Complement, lists all the fuses used, by component, along with the quantity, type number and ampere rating of each.

TABLE II. EQUIPMENT LIMITATIONS

POWER REQUIREMENTS	FREQUENCY RANGE	SENSITIVITY (1 inch deflection, 1 mc spectrum width)		STABILITY	SPECTRUM WIDTH	RESOLUTION	TEMPERATURE RANGE
		RANGE (mc)	SENSITIVITY (dbm)				
115 volts, 60 cps 250 watts, max.	10 to 16,000mc	10-100	-63	0.5% under all operating conditions	1 to 25-mc	10-kc	OPERATING 0° C to 55° C (32°F to 131°F)
		100-350	-57				
		350-1000	-52				NON-OPERATING -40° C to 71° C (-40° F to 160° F)
		1,000-16,000	-50				
		1,000-16,000	-40 (25-mc spectrum width)				

TABLE III. EQUIPMENT SUPPLIED

QUANTITY PER EQUIPMENT	NAME OF UNIT	GOVERNMENT TYPE DESIGNATION
1	Pulse Analyzer Indicator	IP-130/UPM-17
1	R-F Tuner	TN-188/UPM
1	Variable R-F Attenuator	CN-319/U
1	Variable R-F Attenuator	CN-211/U
1	Case	CY-903/UPM-17
1	Cord - 10 feet	CX-1059/U
1	Cord - 6 feet	CG-92E/U
1	Cord - 6 feet	CG-409E/U
1	Special Purpose Cable Assembly	CX-3162/U
1	Special Purpose Cable Assembly	CX-3163/U

TABLE IV. EQUIPMENT REQUIRED BUT NOT SUPPLIED

No equipment is required other than that supplied.

TABLE V. TUBE COMPLEMENT

COMPONENT	JAN NO.	REFERENCE SYMBOL	FUNCTION	QUANTITY
1-MC I-F Amplifier	6AU6WA	V1205	Square Law Detector	2
		V1206	Square Law Detector	
	5725/6ASGW	V1202	Mixer	1
	1/2 12AT7WA	V1201	Oscillator	
	1/2 12AT7WA		Frequency Doubler	2
	12AT7WA	V1204	Phase Inverter	
	6186/6AG5WA	V1203	Amplifier	1
64-MC I-F Amplifier	6AN4	V1101	Mixer	1
	5654/6AK5WA	V1102	I-F Amplifier	4
		V1103	I-F Amplifier	
		V1104	I-F Amplifier	
		V1105	I-F Amplifier	

TABLE V. TUBE COMPLEMENT (cont)

COMPONENT	JAN NO.	REFERENCE SYMBOL	FUNCTION	QUANTITY
160-MC I-F Amplifier	5654/6AK5WA	V2201	I-F Amplifier (Wideband)	
		V2202	I-F Amplifier (Wideband)	
		V2203	I-F Amplifier (Wideband)	
		V2204	I-F Amplifier (Wideband)	10
		V2205	I-F Amplifier (Wideband)	
		V2206	I-F Amplifier (Wideband)	
		V2207	I-F Amplifier (Wideband)	
		V2208	I-F Amplifier (Narrowband)	
		V2209	I-F Amplifier (Narrowband)	
		V2210	I-F Amplifier (Narrowband)	
Sweep Frequency Generator	5654/6AK5W	V1501	Reactance Modulator	
		V1505	Frequency Triple	3
		V1506	Frequency Double	
	6AH6	V1503	R-F Amplifier	
		V1504	R-F Amplifier	5
	12AT7WA	V1502	Frequency Modulated Oscillator	1
Oscillator 1 and 2	6AN4	V2504	Mixer	2
		V2502	Mixer	
	12AT7WA	V2503	Oscillator	1
	6AF4	V2501	Oscillator	1
Oscillator 3	5675	V2701	Oscillator	1
		Z2702	Mixer (Crystal)	1
Oscillator 4	2C36	V2901	Oscillator	1
		Z2902	Mixer (Crystal)	1
Power Supply and Video	12AU7	V1301	Multivibrator	
	1/2 12AU7	V1302	Sweep Generator	
	1/2 12AU7		FM Sweep Amplifier	4
	12AU7	V1305	Video Amplifier	
	1/2 12AU7		D.C. Restorer	
	1/2 12AU7	V1307	Intensifier Amplifier	
	12AT7WA	V1304	Video Amplifier	1
	6AU6WA	V1306	Intensifier Squaring	1
	6080	V1311	Series Regulator	2
			Series Regulator	
	OB2WA	V1310	Voltage Regulator	1
	12AX7	V1303	Sweep Amplifier	3
		V1309	Amplifier	
		V1312	Amplifier	
Spectrum Calibrator	12AT7WA	V1401	Oscillator	1
Pulse Analyzer Indicator IP-130/UPM-17	5CP1A	V1001	Cathode-Ray Tube(Display)	1

TABLE VI. FUSE COMPLEMENT

COMPONENT	FUSE	RATING (amps)	TYPE NO.
Pulse Analyzer Indicator IP-130/UPM-17	F1001	3	3A-G
	F1002	3	3A-G
Power Supply	F1301	1	3A-G
	F1302	.25	3A-G

SECTION II

TEST EQUIPMENT AND TOOLS

2-1. GENERAL.

2-2. This section provides a list of special tools and test equipment required for maintenance of the spectrum analyzer. Common types of tools ordinarily used are not listed.

2-3. SPECIAL TOOLS AND TEST EQUIPMENT.

2-4. Test equipment required for maintenance of the spectrum analyzer is listed on table VII. No special tools are required for the maintenance of the spectrum analyzer.

TABLE VII. TEST EQUIPMENT

NAME	AN TYPE OR MFG DESIGNATION	ALTERNATE	USE
Frequency Meter	FR-6 (AN/URM-81)		Generates standard frequency from 100 to 500-mc for comparison.
Frequency Meter	FR-61		Generates standard frequency from 500 to 2000-mc for comparison.
Signal Generator	Hewlett Packard Model 608		Generates a calibrated output from 10 to 500-mc as necessary.
Signal Generator	TS-418 (AN/URM-49)		Generates a calibrated output from 400 to 1000-mc as necessary.
Signal Generator	TS-419		Generates a calibrated output from 900 to 2100-mc as necessary.
Signal Generator	Hewlett Packard Model 616A		Generates a calibrated output from 2000 to 4000-mc as necessary.
Signal Generator	Polytechnic Research and Development Model 902		Generates a calibrated output from 4000 to 7500-mc as necessary.
Signal Generator	Polarad Model MSG-4		Generates a calibrated output from 12,400 10,750-mc as necessary.
Signal Generator	Polarad Model SGX-12		Generates a calibrated output from 7000 to to 17,500-mc as necessary.
Audio Oscillator	Hewlett Packard Model 200C		Generates audio frequencies as necessary for comparison.
Pulse Generator	TS-592/U		Generates pulses for the horizontal linearity check.
Multi-tester	Simpson Model 260	Triplett Model 630	Measures resistance and voltage as necessary.
A-C VTVM	Balantine Model 300	Daven Model 170A	Measures a-c voltage as necessary.
"VARIAC"	General Radio Type J-10MT		Sets the a-c power source voltage.
A-C Voltmeter	AN/PSM-3		Measures the a-c power source voltage.

SECTION III

PREPARATION FOR USE AND RESHIPMENT

3-1. GENERAL.

3-2. This section describes the steps necessary to make the equipment operable and to prepare it for reshipment. Instructions are included for unpacking and packing the equipment for shipment or storage.

3-3. REMOVAL OF EQUIPMENT FROM TRANSIT CASE.

3-4. Remove the spectrum analyzer from the transit case as follows:

a. Lift the ten latches which secure the top cover of the transit case to the box. Remove the top cover.

b. To remove the spectrum analyzer from the transit case, unscrew the four wing nuts, remove the corresponding retaining plates in the interior corners of the case, and the bar from across the face of the instrument.

c. Lift the analyzer out of the case carefully by grasping the handle bars of the instrument. Place the analyzer carefully on the work bench.

d. Remove the r-f attenuators from the metal container or the interior of the top cover by detaching the metal clamps which secure the attenuators to the cast mounting.

e. Remove the test cables from the other metal container.

3-5. RESHIPMENT OR STORAGE OF EQUIPMENT.

3-6. To reship or store the spectrum analyzer, replace the equipment in the transit case by following the procedures given in paragraph 3-4 in the reverse order of removal.

SECTION IV

THEORY OF OPERATION

4-1. GENERAL.

4-2. This section contains a discussion on the theory of operation of the spectrum analyzer. The theory is described primarily for maintenance technicians equipped with experience on similar or related equipment. The basic principles and general theory of spectrum analyzers are not covered in this handbook since such information is included in textbooks on microwave measuring equipment. The description given in this handbook covers a treatment of circuitry operation characteristic to the particular equipment. With the aid of a functional block diagram, a description of circuit operation is given in the order of signal sequence. A detailed circuit analysis of each component is included and references are made to simplified electrical schematics.

4-3. FUNCTIONAL OPERATION OF THE ANALYZER.

4-4. Shown in figure 4-1 is a functional block diagram of the spectrum analyzer, indicating a signal flow. The spectrum analyzer, incorporating a narrowband receiver, is physically divided into two major components: the Pulse Analyzer Indicator IP-130/UPM-17 and the R-F Tuner TN-188/UPM. The Pulse Analyzer Indicator IP-130/UPM-17 is actually a complete spectrum analyzer which covers a frequency range from 145 to 175 mc. The R-F Tuner TN-188/UPM is primarly a frequency converter which changes the frequency range of 10 to 16,000 mc into a basic frequency range of 145 to 175 mc. The converted signal from the tuner unit is fed to the indicator unit where the time signal is changed to a frequency domain signal. This latter signal is that which is viewed on the cathode-ray tube screen on the panel of the indicator unit. The scope pattern produced is a plot indicating power vertically and frequency horizontally.

4-5. The incoming r-f signal may enter one of the four input receptacles on the tuner-drawer panel to accommodate the range of r-f frequencies to be analyzed. Each incoming signal is fed to one of four mixers (V2504, V2502 in oscillator 1 and 2, or the crystals in oscillator 3 and oscillator 4). A local oscillator (V2503, V2501, V2701, or V2901) generates a signal to beat against the incoming r-f signal in one of the mixers. The frequency of the local oscillator is made variable by manual use of the "TUNE" control on the panel of the tuner-drawer. If the difference between the local oscillator frequency and the incoming r-f frequency is equal to the i-f frequency (160 mc), a signal is produced at the output of the mixer which is proportional to the r-f signal. The mixer output signal (the difference frequency, 160 mc) is then fed to the 160-mc i-f amplifier through the band selector switch

S2202. This switch enables selection of one of the four mixer output signals, feeding it to either the wideband (24 mc) or the narrowband (5 mc) i-f amplifier.

4-6. The 160-mc i-f amplifier is used to perform the following functions: a) to wideband amplify the signal before the time-domain, frequency-domain conversion; b) to discriminate against the image frequency (352 mc) of the 64-mc oscillator; c) to provide isolation between the first mixer and the mixer V1101 in the 64-mc i-f amplifier (possessing sawtooth signal), thereby preventing sawtooth or frequency modulated signals from being present at the input receptacles on the tuner-drawer panel; d) to introduce the spectrum calibrator into the system.

4-7. The output of the i-f amplifier can be attenuated from zero to 60 db in 6 db steps by manual control of the i-f attenuator switch S2002 on the panel of the tuner-drawer panel. A signal from a frequency marker oscillator (spectrum calibrator) also feeds to the input of the 160-mc amplifier. The spectrum calibrator contains a tunable high frequency oscillator which produces a marker pip, adjustable in amplitude and frequency, on the scope screen. The marker pip permits frequency measurements of the scope pattern to be conveniently made.

4-8. The output signal of the 160-mc i-f amplifier is then fed from the tuner-drawer to the indicator drawer where it is introduced into a 64-mc i-f amplifier together with the output of the sweep frequency generator. The 64-mc i-f amplifier is actually a second mixer which converts the 160-mc input to the low frequency of 64-mc. The output of the sweep frequency generator is centered about 224-mc and is frequency modulated by means of a sawtooth voltage. The frequency deviation is plus and minus 1/4 mc, minimum, to plus and minus 12-1/2 mc, maximum. In addition, the center frequency may be varied plus and minus 15-mc about the mean of 224-mc. The result is a series of 64-mc signals all occurring at different sequential times. These signals are then fed to the V1202 mixer in the one-megacycle i-f amplifier.

4-9. In the 1-mc i-f amplifier a local crystal oscillator Y1201 generates a frequency of 32.5-mc which is fed to a frequency doubler V1201. The doubler doubles the 32.5-mc signal to produce an output of 65-mc which is fed to the input of mixer V1202. Mixer V1202 mixes the 65-mc signal and the 64-mc input signal to produce a difference frequency of one megacycle. The 1-mc signal is then amplified by amplifier V1203, inverted by phase inverter V1204, and fed to a square law detector V1205. The detector operates at a small signal level to produce an output voltage which is square law. The output of the detector is then fed to the video circuitry in the power supply and video unit. This unit contains sawtooth generating circuits, performing the dual purpose of modulating the sweep frequency generator as well as deflecting the cathode-ray beam.

4-10. DETAILED CIRCUIT ANALYSIS.

4-11. R-F TUNER TN-188/UPM.

4-12. OSCILLATORS 1 AND 2.

4-13. Shown in figure 4-2 is the electrical schematic of the two segments of the oscillators 1 and 2 unit. Each segment (oscillator 1 or oscillator 2) consists of an oscillator stage and a mixer stage. The oscillator 1 segment consists of a 12AT7WA (V2503) tube, in a push-pull oscillator circuit, generating frequencies between 170 and 320-mc. Also part of the oscillator 1 segment is the mixer stage using triode 6AN4 (V2504) which receives the 10-150-mc input signal and mixes it with the output signal from V2503. The oscillator 2 segment uses a 6AF4 (V2501) tube, in a modified Colpitts oscillator, generating frequencies between 300 and 530-mc. Also part of the oscillator 2 segment is the mixer stage using triode 6AN4 (V2502) which receives the 150-350-mc input signal and mixes it with output signal from V2501.

4-14. All supply voltages to the operating stages of oscillator 1 and oscillator 2 originate from the power supply and video unit in the indicator drawer. Plate supply voltage (+ 150 V) is supplied to the multivibrator V2503 through inductances L2506, L2507 and L2510, and resistance R2508. Filament voltage (6.3 V ac) is supplied to V2503 through inductances L2511 and L2509. Plate voltage is applied to mixer V2504 through inductances L2506 and L2513 and resistances R2510 and R2514. Filament voltage is supplied to V2504 through inductances L2515 and T2503. For oscillator V2501, plate voltage is supplied through inductances L2501 and L2502 and resistance R2501. Filament voltage is applied through inductances L2508 and T2501. For mixer V2502, plate voltage is supplied through inductances L2501 and L2503 and resistances R2502 and R2507. Filament voltage is applied through inductances L2508 and T2502.

4-15. The V2501 oscillator stage is a modified version of the Colpitts Oscillator. The circuit is particularly suitable for frequency generation in the range of 300-500-mc, because feedback is obtained by the plate to cathode capacity of V2501 (6AF4). The 6AF4 tube contains sufficient plate to cathode capacity to obtain the required amount of feedback needed at the prescribed frequency range of operation. Capacitor C2506 (0.22 mmfd) is used to increase the feedback from plate to cathode of V2501. Capacitor C2503 is made variable by manual control of the "TUNE" knob on the tuner-drawer panel. Varying this capacitance shifts the frequency of oscillation between 300 and 500-mc. The tune circuit of this oscillator is not a normal type of tuned circuit. A parallel wire transmission line is used to transform the impedance of the variable capacitor C2503 to a variable inductance at the tube terminals so that, as the capacitor is varied, tube V2501 "sees" a varying inductance. This inductance is tuned with the plate-grid capacity of V2501, capacitance C2505, the capacity presented by the tube due to the plate to cathode and grid to cathode capacitance, and the mutual conductance of the tube.

4-16. The output of oscillator V2501 is picked off at inductance L2502 which is magnetically coupled to inductance L2504. In this way, the output of V2501 is fed to the input of mixer V2502 by way of inductance

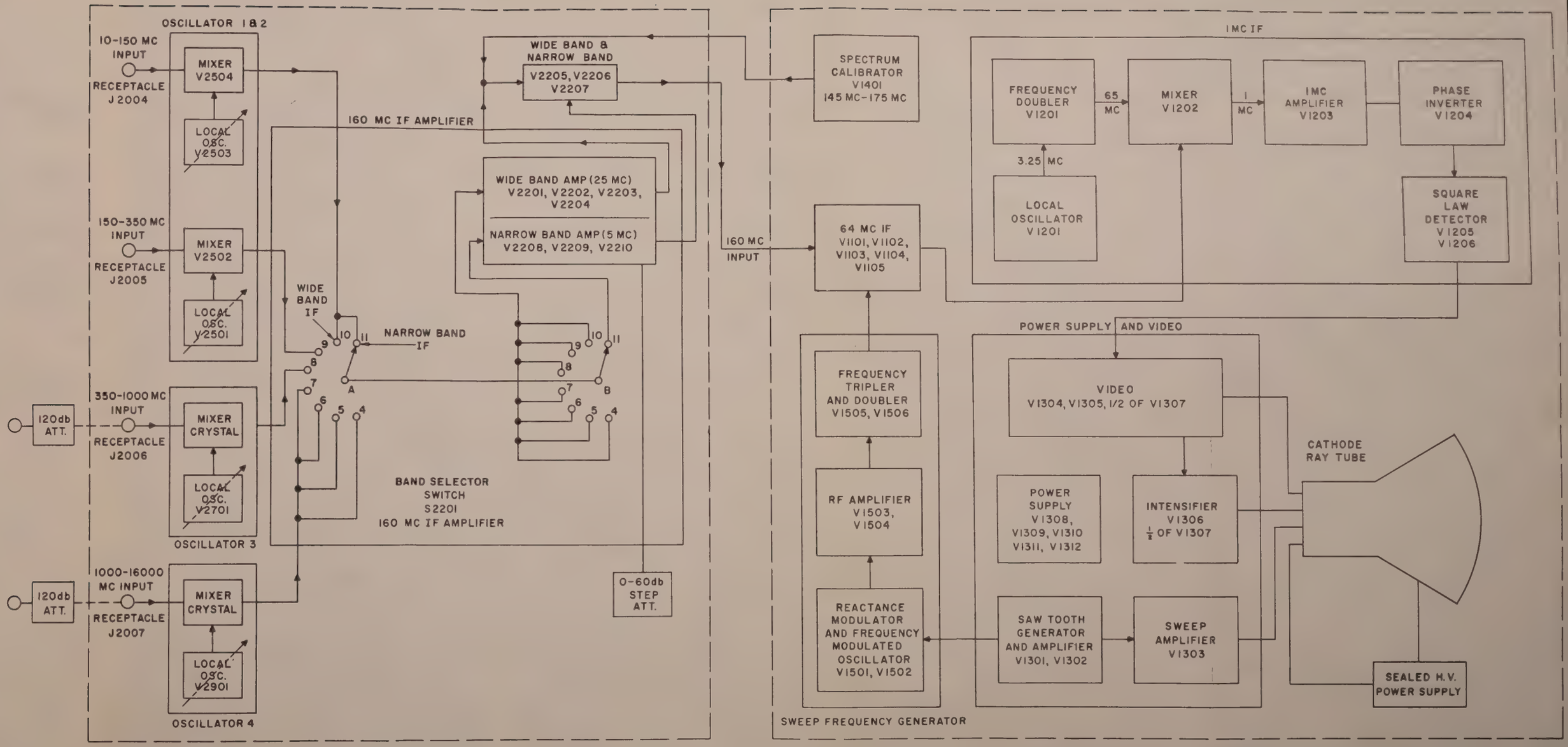


Figure 4-1. Spectrum Analyzer Functional Block Diagram

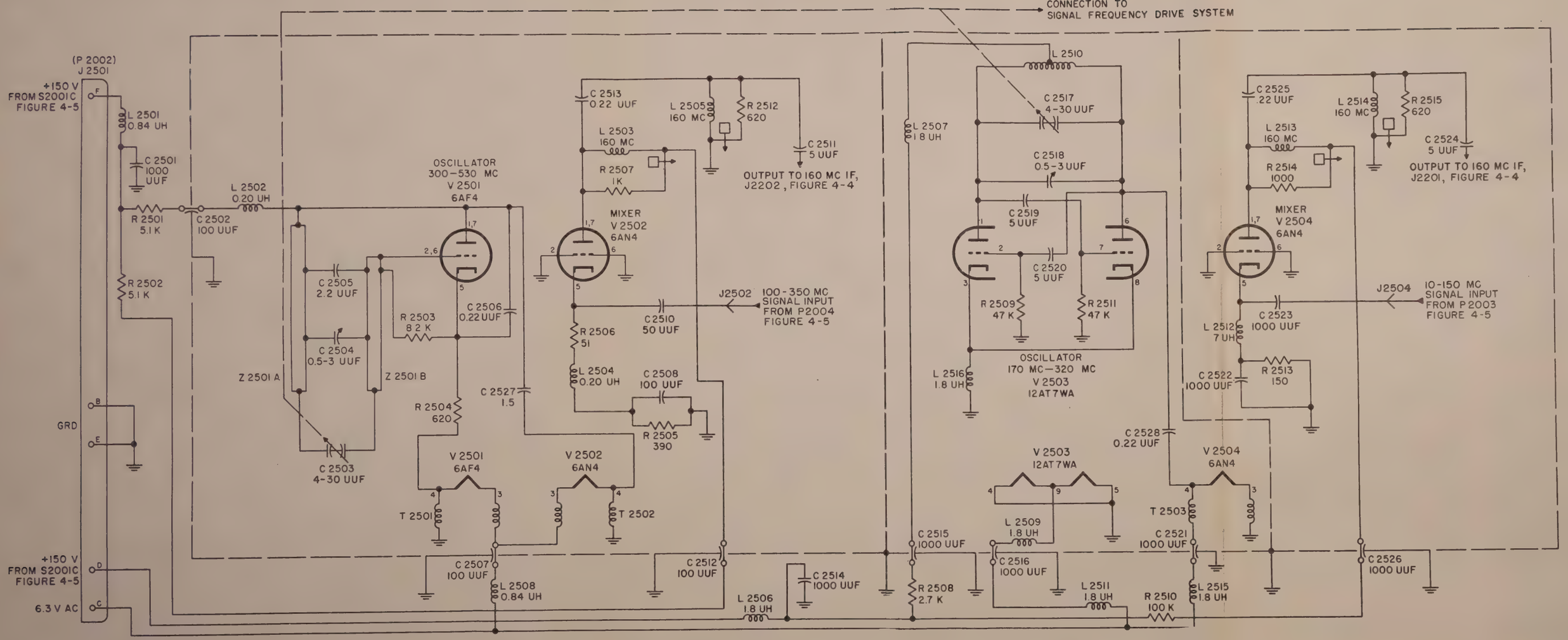


Figure 4-2. Oscillators 1 and 2 Schematic Diagram

L2502 and resistance R2506. The input signal to the analyzer, which passes through capacitor C2510, is combined with the oscillator output signal at the cathode of mixer V2502. The output signal in the plate circuit of mixer V2502 is 160-mc in frequency, and is then fed to the 160-mc i-f amplifier.

4-17. Both mixer stages in oscillator 1 and 2 unit perfrom the function of transforming the signal to be inspected into the frequency range of 145 to 175-mc. Triodes are employed primarily to reduce noise. To use triode mixers at such high frequencies, the grids must be grounded or oscillations will occur. In addition, the grounded grid mixers provide a low input impedance for matching the impedance of the 50-ohm systems required. The plate circuits of both mixers are double tuned in order to obtain the wide band width required. The chokes in the filament circuits of both mixers are used to keep the cathodes further off the ground.

4-18. The V2503 oscillator stage is essentially a relaxation oscillator. This push-pull oscillator is very suitable for generating frequencies in the range of 170-320-mc. Capacitance C2517 is made variable by manual control of the "TUNE" knob on the tune-drawer panel. Varying this capacitance causes oscillations to occur between 170 and 320-mc. The output of the oscillator V2503 is picked off on inductance L2507 which is magnetically coupled to inductance L2512. In this manner, the output of the oscillator is fed to the cathode of mixer V2504 through inductance L2512. The input signal to the analyzer, which passes through capacitor C2510, is combined with the oscillator output signal at the cathode of mixer V2504. The output signal in the plate circuit of mixer V2504 is 160-mc in frequency and is then fed to the 160-mc i-f amplifier.

4-19. OSCILLATOR 3 AND OSCILLATOR 4.

4-20. The theory of operation of both oscillator 3 and oscillator 4 are similar. Therefore, only oscillator 4 will be explained. Oscillator 4 is used as the local oscillator for the spectrum analyzer range of 1000 to 16,000-mc. The oscillator circuit shown in figure 4-3 employs a uhf type triode 2C36 (V2901) operating with an external resonant cavity. The entire assembly includes a pair of concentric transmission lines built up mechanically of three metal cylinders mounted coaxially one within the other. The innermost cylinder is in contact with the cathode, the center cylinder is coupled through an air capacitor of low value to the grid, and

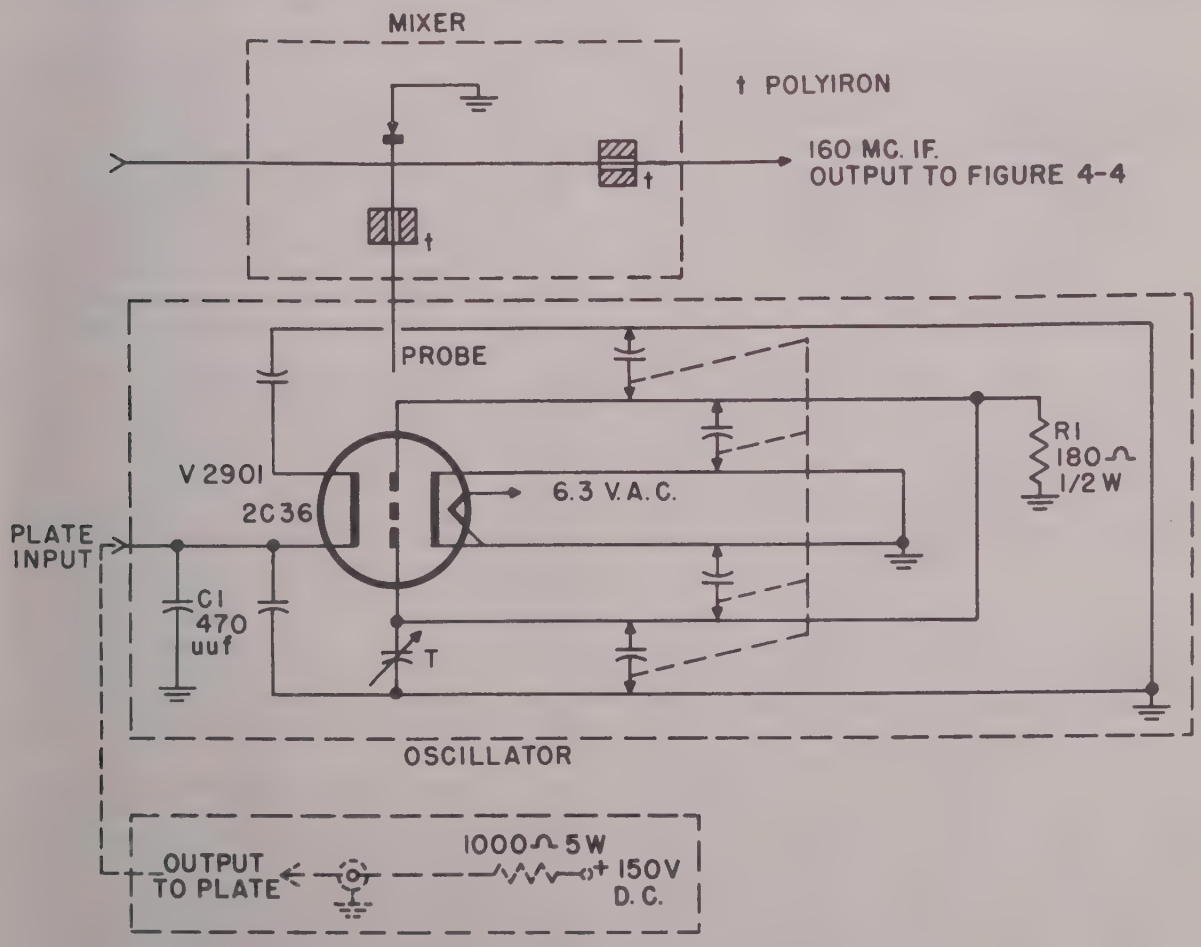


Figure 4-3. Oscillator 4 Schematic Diagram

the outer cylinder is similarly coupled to the plate. The input ends of both transmission lines are effectively open due to the small coupling and the series tube capacitances

4-21. The outer concentric line built up of the two outer cylinders constitutes the resonant cavity. This line is short-circuited at a point one-quarter wavelength from the input, electrically forming the equivalent of a parallel resonant circuit between the plate and the grid. The inner concentric line, which is short-circuited slightly beyond the quarter wavepoint, presents a capacitive reactance between the grid and the cathode. A screw, set into the outer cylinder, passed through a feedback hole in the center cylinder, and extending down into the grid-cathode transmission line, introduces a small capacitance between the plate and the cathode. A loading slug mounted on the inner wall of the grid cylinder, in close proximity to the cathode cylinder, tends to supress higher mode oscillations, In addition to the parallel resonant circuit capacitively coupled between the plate and the grid, the complete oscillator circuit electrically includes two capacitances connected in series between the plate and grid, with the cathode between them. Electrically, the oscillator is equivalent to the Colpitts Oscillator circuit.

4-22. The oscillator frequency is determined by the resonant frequency of the plate line. By changing the position of the plunger contact, which shorts the line, the resonant frequency of the line also changes. A similar shorting contact is located in the grid-cathode line. Both shorting contact plungers are secured to the same geared-drive mechanism so that both are moved in unison by the "TUNE" control, which varies the oscillator frequency throughout its range.

4-23. 160-MC I-F AMPLIFIER.

4-24. Shown in figure 4-4 is the electrical schematic of the 160-mc i-f amplifier. The amplifier consists of a narrowband (5-mc) i-f amplification section and a wideband (25-mc) i-f amplification section. The narrowband section is made up of three (triple) i-f stages V2208, V2209, and V2210. The wideband section is made up of six (two triples) i-f stages V2201, V2202, V2203, V2204, V2205, and V2206, plus a seventh stage, V2207, which is a cathode follower.

4-25. Plate voltage (Narrow B+, 150 V) is supplied to the triple in the narrowband section by way of inductances L2226, L2224, L2223, L2221, and L2220. Plate voltage (Wide B+, 150 V) is applied to the first four i-f stages of the wideband section V2201, V2202, V2203, and V2204 by way of inductances L2212, L2209, L2206, and L2203. Plate voltage (+150 V) is supplied to stages V2205, V2206, and V2207 through inductances L2217, L2215 and resistances R2226, R2222, and R2218. The supply of plate voltage is split in such a manner to permit operation of only such stages as are selected by means of the "BAND SELECTOR" switch S2001 (explained in paragraph 4-32). The band switch arrangement in the tuner-drawer permits the removal of Wide B+ from stages V2201, V2202, V2203, and V2204 when the switch is on "10-150 MCS NARROW" and the removal of Narrow B+ from stages V2208, V2209, and V2210 when the switch is on "10-150 MCS WIDE". In addition, such switching operation does not affect the supply of plate voltage to stages V2205, V2206, and V2207, which also handle the frequency marker signal from the spectrum calibrator.

4-26. The output signal from one of the four mixer stages (160 mcs) enters the input of the 160-mc i-f amplifier through selector switch S2201 (A or B deck of "BAND SELECTOR" switch), Shown in the schematic of figure 4-3 is a table revealing the position of the "BAND SELECTOR" switch S2201 and the corresponding contacts connected for each position. With the switch on "10-150 MCS NARROW," the output of mixer V2504 will feed to the input of the narrowband i-f amplifier V2208 (by way of capacitor C2229 and inductance L2238) because contact 11 of switch S2201A connects with contact 12. Similarly, with the switch on "10-150 MCS WIDE," the output of mixer V2504 will feed to the input of the wideband i-f amplifier V2201 (by way of inductance L2202) because contact 10 of switch S2201B connects with contact 12. On all remaining positions of the "BAND SELECTOR" switch, either the output of mixer V2502, the crystal mixer in oscillator 3, or the crystal mixer in oscillator 4 will feed to the input of the wideband i-f amplifier V2201.

4-27. All the tubes used in the 160-mc i-f amplifier are type 6AK5 possessing a gold-plated grid to obtain maximum gain with a minimum of noise. All stages are tuned with minimum capacity in order to obtain maximum gain. Each of the pentode stages is a typical r-f pentode amplifier, the only difference being the addition of a resistance (22 ohms) between pins 2 and 7. In addition the first i-f amplifier stages (V2201 and V2208) in both the narrowband section and the wideband section contain 51-ohm cathode resistor (R2204 and R2233) and a 39,000-ohm screen resistor (R2201 and R2231) to provide minimum noise generation.

4-28. The input wideband signal to the wideband section is amplified by four i-f stages V2201, V2202, V2203, and V2204, the signal being amplified further by i-f stages V2205 and V2206. The signal is then fed to the cathode-follower stage V2207, which is the output of the 160-mc i-f amplifier. The output signal of the cathode follower is then fed to the 64-mc i-f amplifier in the indicator drawer by way of the interdrawer cable. The cathode-follower stage V2207 is utilized to approximately match the output impedance of the 160-mc i-f amplifier with the interdrawer cable, which is an appreciable number of wavelengths long. The 25-mc bandwidth in the 160-mc i-f amplifier unit is obtained by use of two staggered triples, each triple being approximately 30-mc wide. In cascade, the overall bandwidth reduces to the range of 25 to 30-mc.

4-29. The narrowband input signal to the narrowband section is amplified by three i-f stages V2208, V2209, and V2210. The output from stage V2210 is fed to the control grid of tube V2206, through capacitor C2238, and amplified further. The output of amplifier V2206 is then fed to the cathode follower V2207. The 5-mc bandwidth is obtained by preceding the second 25-mc triple (stage V2206) with two synchronously tuned stages (V2208 and V2209).

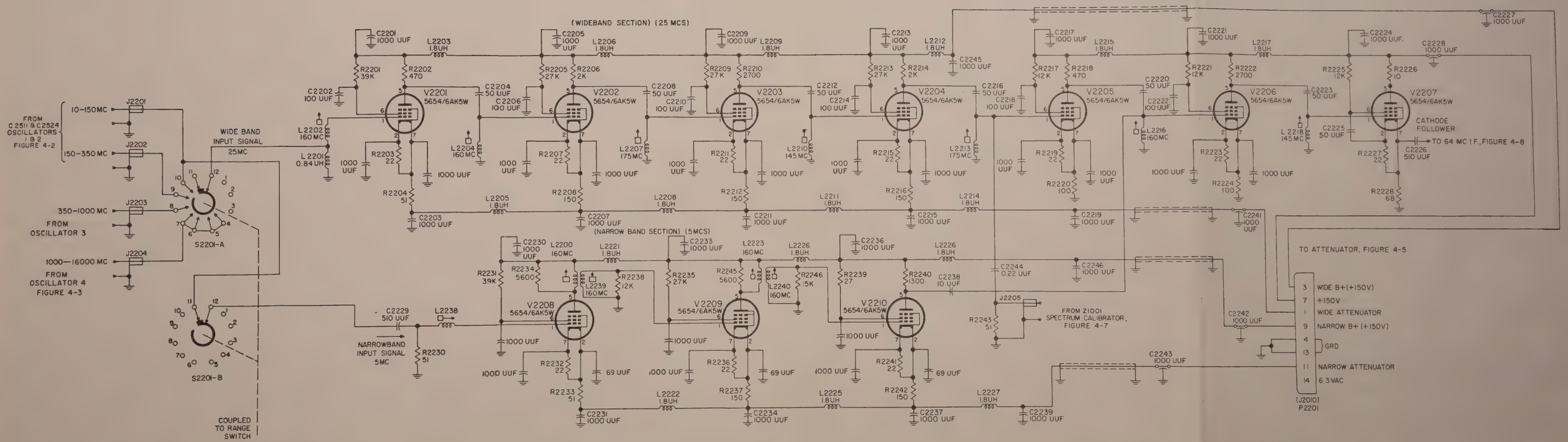


Figure 4-4. 160-MC I-F Amplifier Simplified Schematic

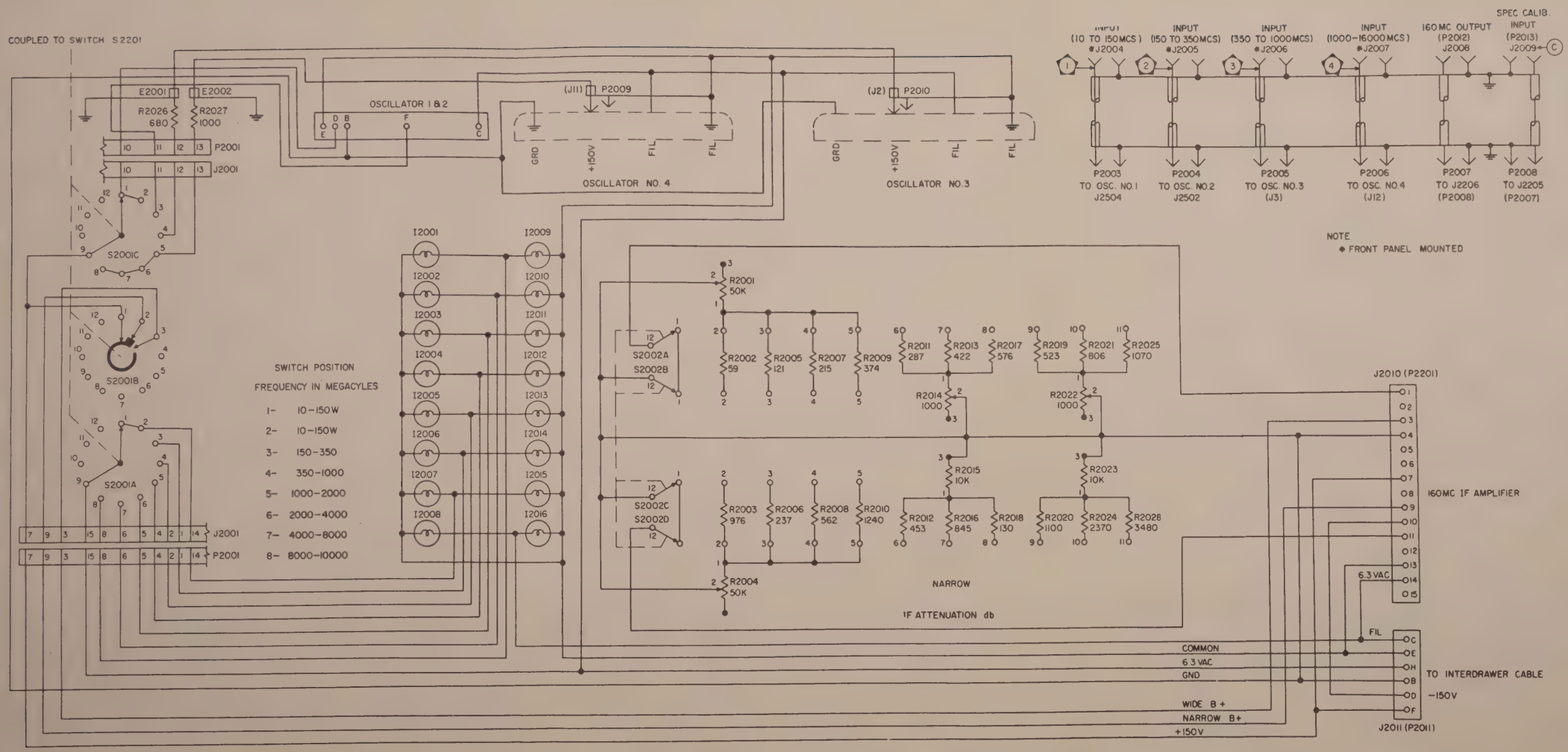


Figure 4-5. R-F Tuner Controls Schematic Diagram

4-30. The output attenuation of the 160-mc i-f amplifier is made controllable by use of the "IF ATTENUATION - DB" switch on the tuner-drawer panel. By manipulating the switch, the cathode resistance of the first triplet (V2201, V2202, V2203, and V2204) in the wideband side, and the first three tubes (V2208, V2209, and V2210) in the narrowband side, is made to vary. The cathode resistance of the first triplet, and of the first three tubes in the narrowband side, are connected in series with resistors on the attenuator switch S2002A and B on the tuner-drawer panel. Effectively, the cathode resistance is increased by inserting increased resistance values in series with the zero db resistance. On the attenuator switch S2002 is mounted a number of resistors arranged in such a manner to permit the addition of resistance to the cathode resistance at each progressive step position.

4-31. The frequency marker signal from the spectrum calibrator enters the 160-mc i-f amplifier through capacitor C2244 and is fed to the control grid of tube V2205. The signal is introduced into the second triple so that it appears with the same relative amplification for both the narrowband and wideband signals, and so that it can be swept flatly over the full 25-mc bandwidth. Introduction of the frequency marker signal into the second triple also allows the signal to be the same amplitude regardless of the position of attenuator switch S2002.

4-32. FUNCTIONAL OPERATION OF R-F TUNER CONTROLS. Shown in figure 4-5 is a schematic of the tuner-drawer, indicating the electrical layout of the controls on the drawer panel. The controls shown schematically are the "BAND SELECTOR" switch S2001 (decks A, B and C) and the "IF ATTENUATION - DB" switch S2002 (decks A and B). The schematic also contains a table revealing the position of the "BAND SELECTOR" switch S2001 and the corresponding contacts of each deck connected for each switch position. The B deck of the selector switch is used to transfer the +150 volts (plate voltage supply) from the output of the power supply and video unit to the narrowband stages and the wideband stages of the 160-mc i-f amplifier. The C deck of the selector switch is used to transfer the +150 volts (plate voltage supply) from the output of the power supply and video unit to oscillator 1 and 2, oscillator 3, and oscillator 4. The A deck of the selector switch is used to transfer the 6.3-volt filament voltage from the power supply to the sixteen indicator lamps I2001 to I2016. The lamps are used to illuminate the selected frequency scale to be read on the "FREQUENCY IN MEGACYCLES" dial. The "IF ATTENUATION - DB" switch S2002 controls the output attenuation of the 160-mc i-f amplifier. As the switch is rotated clockwise, resistances are effectively added to the cathode circuit resistance of the wideband and narrowband stages of the 160-mc i-f amplifier, the A deck of switch S2002 providing wide attenuation, and the B deck providing narrow attenuation. The 25 resistors (R2001 to R2025) are mounted on the attenuator switch S2002 and are arranged functionally to permit the addition of series resistance to the cathode circuit resistance at each progressive step position of the switch knob. The attenuation is increased in steps of 6 db, the range of the switch being from 0 to 60 db.

4-33. PULSE ANALYZER INDICATOR IP-130/UPM-17.

4-34. PRIMARY POWER DISTRIBUTION.

4-35. Shown in figure 4-6 is a schematic showing power distribution to the analyzer. Input power, 115 volts, 50-1000 cps is supplied through two fuses F1001 and F1002. The "POWER" switch S1004, shown in the open ("OFF") position, is used to control the input power to the equipment. With the power switch closed, 115 volts are fed to the high-voltage power supply, and the power supply and video unit. The power supply and video unit produces three output voltages (+150 V dc, -150 V dc, and 6.3 V ac). The three output voltages are fed to the 160-mc i-f amplifier, 1-mc i-f amplifier, 64-mc i-f amplifier, spectrum calibrator, and the sweep frequency oscillator. The +150 V d-c output is plate supply voltage and the 6.3-V a-c output is filament supply voltage. In addition, the 6.3-V a-c supply is used as a source for the indicator lamp I1003 which, when lit, indicates to the operator that power is being delivered to the instrument from an external source. The scale-illumination indicators I1001 and I1002 also use the 6.3-V a-c supply as a source, the indicators being controlled by use of the switch-potentiometer control ("SCALE ILLUMINATION") S1001 and R1003. The lamps illuminate the reticule in front of the cathode-ray tube screen.

4-36. The meter selector circuit consists of milliammeter M1001, "METER SELECTOR" switch S1002A and B, resistors R1011 and R1012, selenium rectifier CR1002, and resistor R1013. This circuit is used to check the power supply and video output voltages (±150 V dc and -150 V dc), also enabling a check to be made on the presence of line voltage (115 V ac). The milliammeter M1001 functions as a voltmeter when the multipliers R1011, R1012, and R1013 are placed in series with the meter. The resistances are placed in series with the milliammeter by use of selector switch S1002. Shown in the schematic is a table revealing the position of the "METER SELECTOR" switch and the corresponding contacts connected for each switch position. Selector switch S1002 is shown in the schematic as being in the "+ 150 V" position. In this position, resistor R1011 is placed in series with the milliammeter so that the meter reads 150 volts dc with respect to ground. With selector switch S1002 in the "-150 V" position, the positive side of the milliammeter becomes grounded through the A deck, while resistor R1012 is placed in series with the meter through the B deck. With meter M1001 grounded as such, the positive side of the meter still remains more positive than the negative side so that, effectively, the meter will read the voltage between the -150 volts line and ground. In the "LINE VOLTS" position, the meter M1001 will read 115 volts dc, the rectified input voltage, 115 volts ac. In this position, the a-c voltage is rectified by selenium rectifier CR1002, and resistor R1013 is placed in series with the meter.

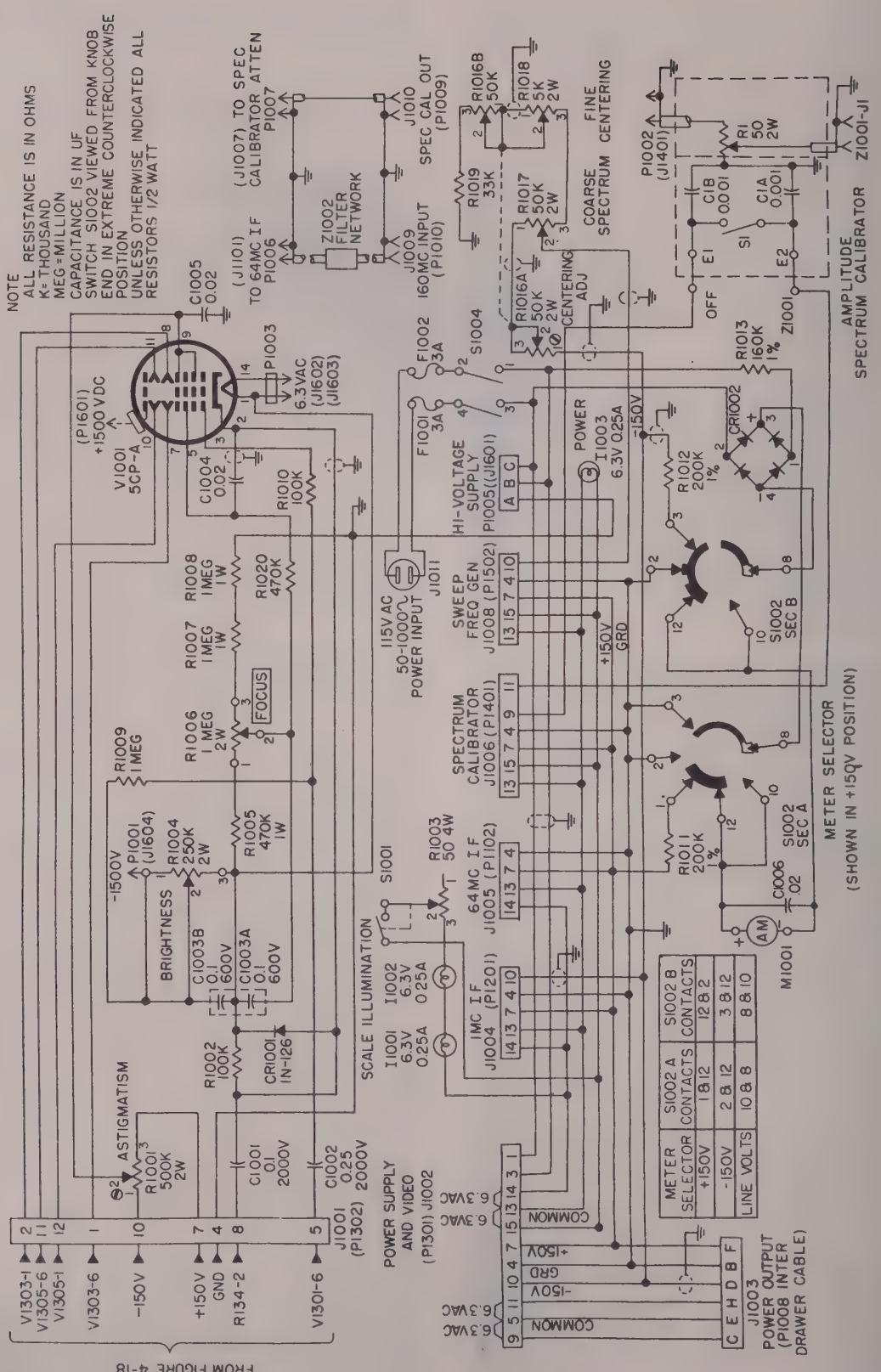


Figure 4-6. Indicator Drawer Schematic Diagram

4-37. SPECTRUM CALIBRATOR.

4-38. Shown in figure 4-7 is a simplified schematic of the spectrum calibrator. The spectrum calibrator is a push-pull oscillator, operating in the frequency range of 145 to 175-mc. A dual triode type tube 12AT7 (V1401) is used. The circuitry of this oscillator is essentially the same as oscillator 1, expect that the spectrum calibrator oscillator operates at a reduced frequency range. Since the oscillator is push-pull, it is quite stable for the specified operating frequency range, the frequency stability falling within 10 - mc per second per hour.

4-39. The spectrum calibrator circuitry is physically divided into two assemblies: the attenuator unit Z1001 and the spectrum calibrator unit. The sealed attenuator unit is mounted in back of the front panel of the indicator drawer and contains a switch-potentiometer control S1 and R1. The remaining components of the spectrum calibrator circuitry shown on the schematic are located in the spectrum calibrator unit. The attenuator unit Z1001 performs two functions: to control the plate supply voltage from the power supply and video unit to the oscillator, and to control the output attenuation of the oscillator. With switch S1003 in the on position ("CLOSED"), the plate supply input voltage (+150V) to the spectrum calibrator is fed to inductances L1401, L1403, and L1404. The potentiometer R1014 ("AMPLITUDE") is used to vary the output signal of the oscillator which if fed to the 160-mc i-f amplifier in the tuner-drawer. The spectrum calibrator unit is interlocked between the wiring leads of switch S1. This is done so that plate supply voltage is removed from the switch terminals when the spectrum calibrator unit is not in place.

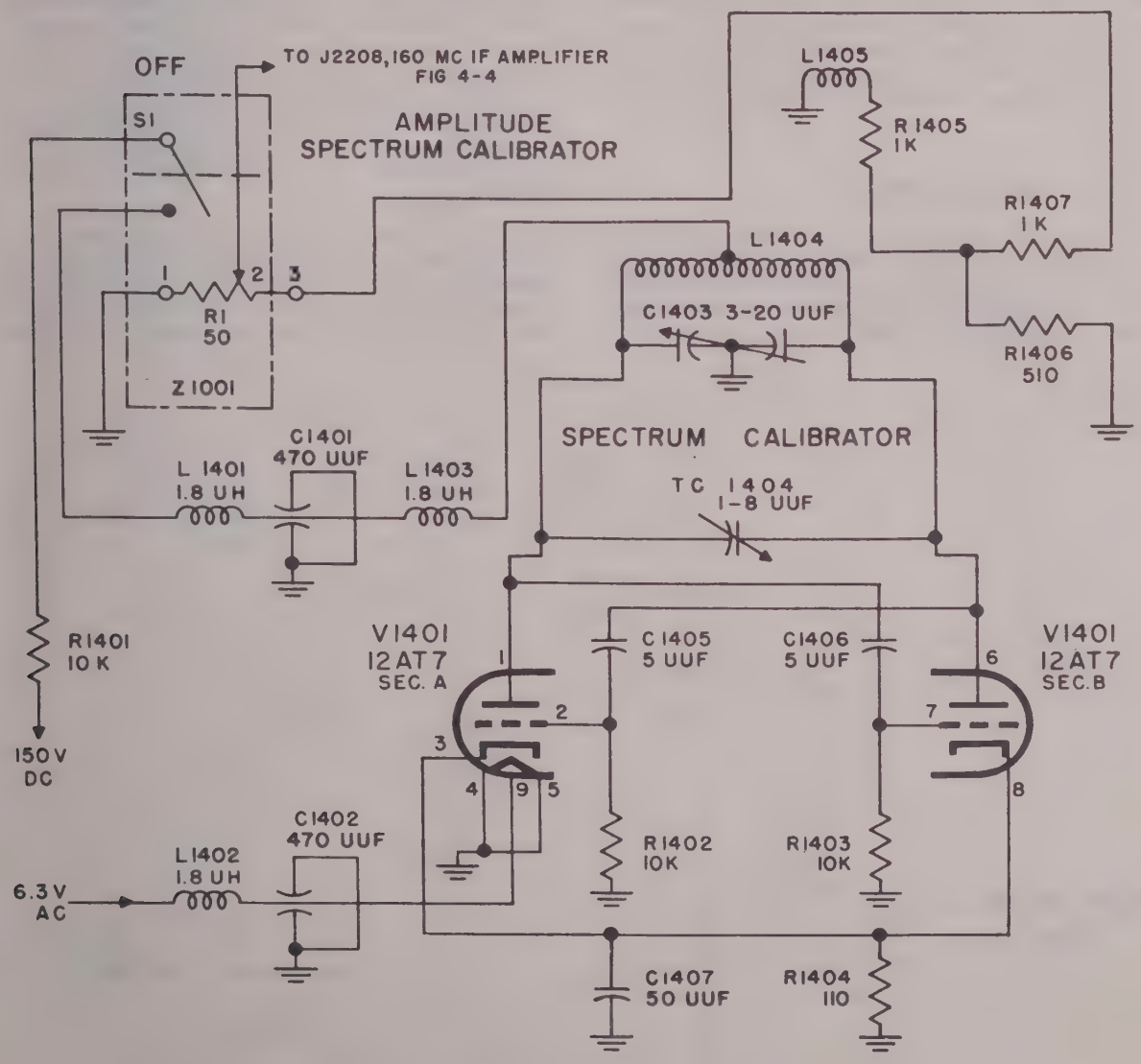


Figure 4-7. Spectrum Calibrator Simplified Schematic

4-40. The oscillator tank circuit consists of capacitors C1403, C1404, and inductance L1404. The output of the oscillator is obtained by an inductance L1405 (possessing a small loop) which is magnetically coupled to the oscillator tank circuit. Since the oscillator output is quite strong, it passes through a R-pad of resistors (R1405, R1406, and R1407) and then to the attenuator unit Z1001. The variable capacitor C1404 is a trimmer capacitor used to account for changes in replacement of tube V1401. Only a small portion of capacitor C1403 is used due to the small frequency range of the oscillator. Capacitor C1403 is varied by use of the "SPECTRUM CALIBRATOR" frequency control ("FREQUENCY") on the panel of the indicator drawer. Capacitor C1403 is shafted to this control through a waveguide below cutoff. The shaft is an insulated material inside a hollow tube which also acts as a bearing or bushing. The attenuation of this tube is over 100 db at the frequency range of the spectrum calibrator. The spectrum calibrator signal is introduced into the second triple of the 160-mc i-f amplifier so that it is available for operation, regardless of whether wide or narrow position is used, and regardless at which position the step-attenuator control "IF ATTENUATION - DB" is set.

4-41. 64-MC I-F AMPLIFIER.

4-42. Shown in figure 4-8 is a simplified schematic of the mixer stage V1101, which is the input stage of the 64-mc i-f amplifier. The remaining stages of the 64-mc amplifier, which consists of four i-f amplifier stages V1102, V1103, V1104, and V1105, are illustrated in figure 4-9 and discussed in subsequent paragraphs. The two input signals to the triode mixer V1101 are derived from the sweep frequency generator and the 160-mc i-f amplifier. The signal from the sweep frequency generator is fed to the grid of mixer V1101, while the signal from the 160-mc i-f amplifier is fed to the mixer cathode. The two signals are combined in the triode and the output appears in the tank circuit L1101, C1103, and C1125, which is tuned to 64-mc. The 64-mc output signal is then fed to the control grid of the first i-f amplifier stage V1102.

4-43. The triode mixer is used to reduce noise, thereby increasing the sensitivity. It must be grounded grid since grounded cathode triodes will oscillate at 64-mc. The triode mixer functionally operates under grounded-grid conditions at the signal frequency of 160-mc, even through the 224-mc signal from the sweep frequency generator is injected into the grid. Due to the tuned-circuit output stage of the sweep frequency generator, the output signal of this generator is fed at a low impedance level to mixer stage V1101. The impedance at 160-mc is exceptionally low. The values of the cathode resistor R1102 and the plate-dropping resistor R1104 in the mixer provide good mixing operation for use with the output levels of the sweep frequency generator.

4-44. Shown in figure 4-9 is a simplified schematic of the amplifier stages in the 64-mc i-f amplifier. The sensitivity of the 64-mc i-f amplifier unit under normal operating conditions is about 4.5 to 6 microvolts for a signal-to-noise ratio of two to one when the input signal

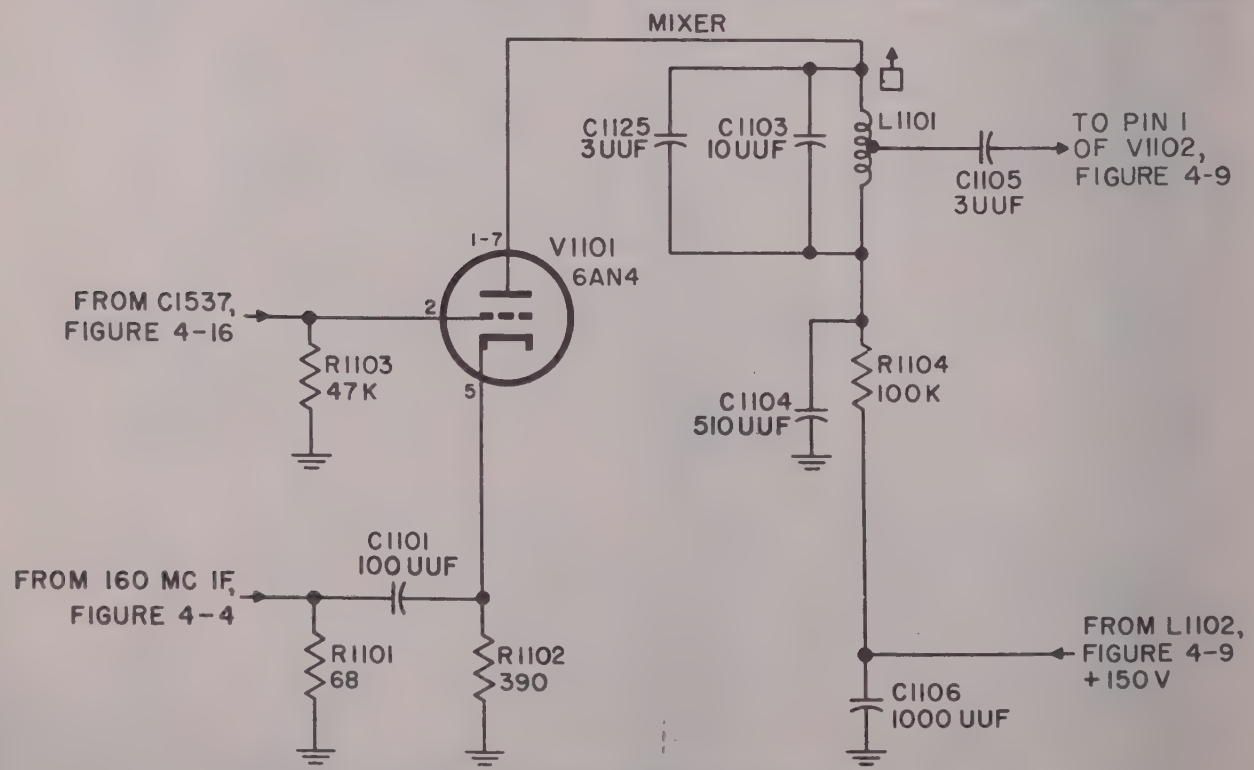


Figure 4-8. Mixer Stage V1101, 64-MC I-F Amplifier Simplified Schematic

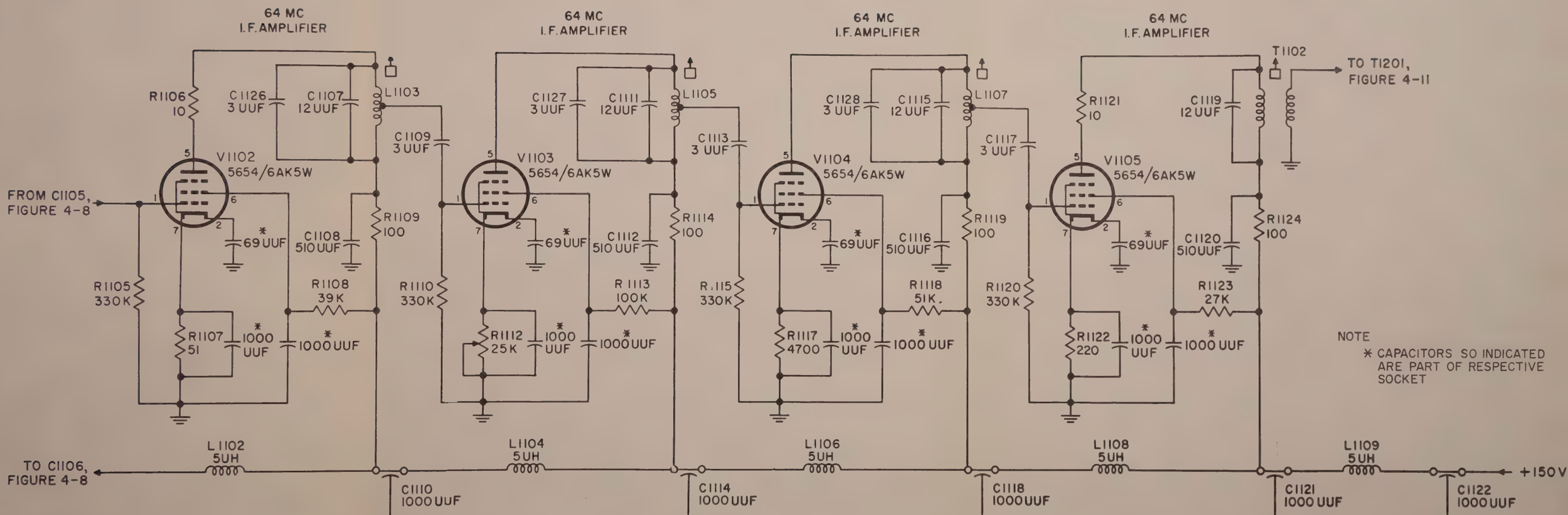


Figure 4-9. I-F Amplifier, 64-MC I-F Amplifier Simplified Schematic

is 160-mc. The bandwidth of the amplifier is in the order of 200 kilocycles. Each of the four i-f amplifier stages, incorporating pentode type tubes, amplify the 64-mc input signal. The output signal in the last i-f amplifier stage V1105 is then fed to the mixer stage V1202 in the 1-mc i-f amplifier. The output of each amplifier stage contains a tuned circuit similar to the tuned circuit used in the output of the mixer V1101. The Q of the tuned circuit in the plate of the mixer is lower than the Q of the tuned circuit in the plate of the i-f amplifiers. This is due to the smaller plate resistance of the V1101 triode. All coils in the output of each i-f amplifier stage are tapped to reduce loading on the tuned circuits due to the input conductance of the following tube.

4-45. The first pentode amplifier stage V1102 contains a 51-ohm cathode resistance R1107 and a 39,000-ohm screen-dropping resistance R1108 in order to place the equivalent noise resistance of this tube at a minimum. The capacitors C1108, C1112, C1116, and C1120 are 510 mmfd in value, being used as bypass capacitors. The 100-ohm resistors R1109, R1114, R1119, and R1124 prevent the formation of a high-Q resonant circuit, which might result between each of the capacitors just mentioned and the corresponding B+ bypass capacitors C1110, C1114, C1118, and C1121.

The second amplifier stage V1103 contains a variable resistor R1112 for gain control. Clockwise rotation of the shaft of this gain control (from the top of the chassis) increases the gain by decreasing cathode resistance and thus the bias. The screen resistor R1113 prevents the 140-volt rating of tube V1103 from being exceeded for various settings of the gain control R1112. The third amplifier stage V1104 contains a larger cathode resistance R1117 in order to decrease the gain of this stage for the purpose of cutting down overall regeneration.

4-46. The 10-ohm resistors R1106 and R1121 in the plate circuit of tube stage V1102 and tube stage V1105, respectively, are anti-parasitic resistors. The two resistors are also used to cut down regeneration due to extra loading on the respective coils L1103 and T1102. The tuned circuit in the plate of amplifier V1105 contains a different coil-capacitor combination than the previous stages. The tuned circuit of amplifier V1105 is used primarily for impedance matching, not contributing much to the selectivity of the amplifier. Note that the 64-mc i-f amplifiers make use of a plexicon tube socket which contains built in bypass capacitors. The capacitors are marked with an asterisk on the schematic, figure 4-9, and are used as bypass capacitors for the cathode, screen, and heater elements

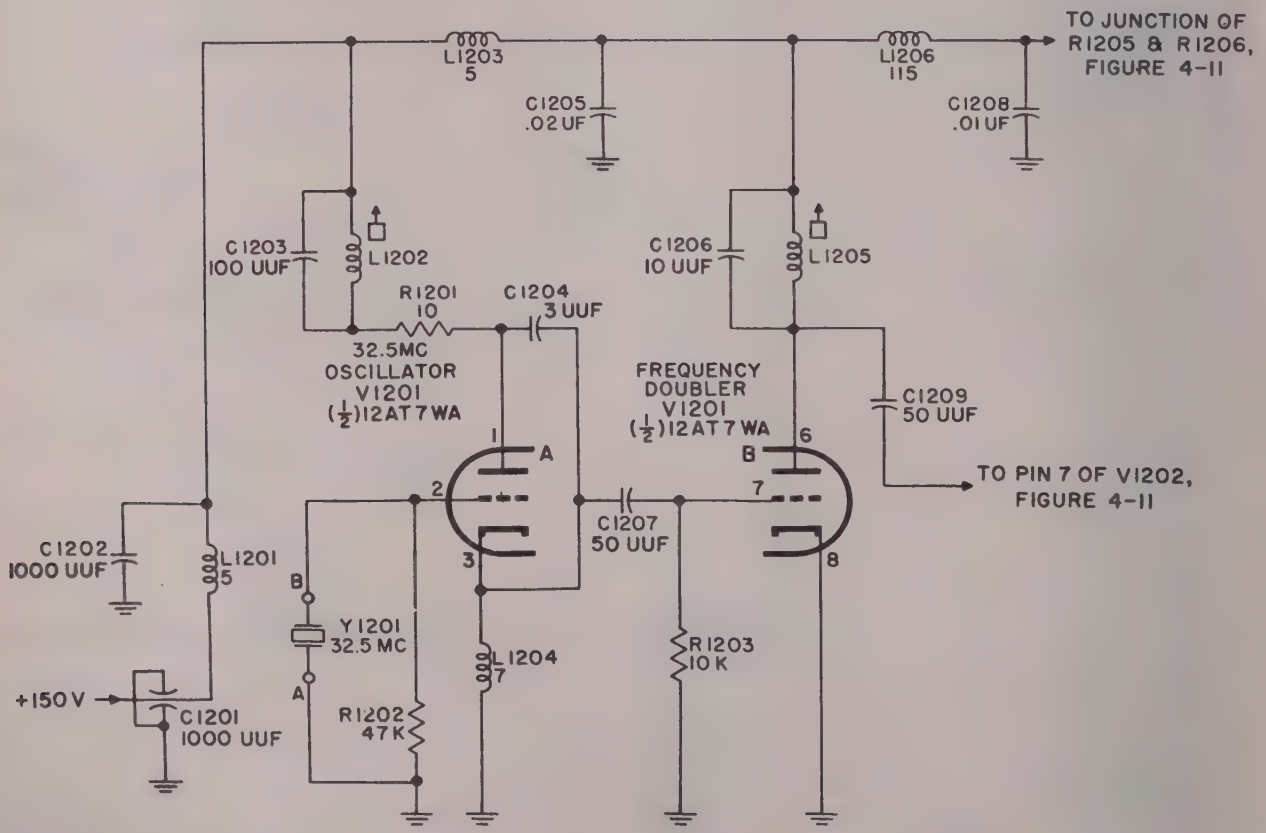


Figure 4-10. 65-MC Local Oscillator, 1-MC Amplifier Simplified Schematic

of each amplifier tube. The bandwidth of the amplifier is in the order of 200 kilocycles.

4-47. 1-MC I-F AMPLIFIER

4-48. The 1-mc i-f amplifier unit consists of four major functional segments: the 65-mc local oscillator V1201 mixer V1202, 1-mc amplifier V1203, and phase inverter V1204 and square law detectors V1205, V1206. Shown in figure 4-10 is a simplified schematic of the 65-mc local oscillator. This segment consists of a crystal-controlled oscillator and a frequency doubler. The crystal Y1201 is used to generate a frequency of 32.5-mc. The V1201 tube is a dual triode (12AT7WA), the first half of which is utilized as a 32.5-mc oscillator and the second half of which is used as a frequency doubler. The oscillator used is of the plate-to-cathode feedback type, feedback taking place through capacitor C1204. The output of the oscillator is fed to the grid of frequency doubler V1201 through capacitor C1207. This stage operates under Class C conditions. A tuned circuit, consisting of capacitor C1206 and inductor L1205, is used in the plate circuit of the frequency doubler and is tuned to 65-mc. The 65-mc output signal is fed to the suppressor grid of mixer tube V1202.

4-49. Shown in figure 4-11 is a simplified schematic of the mixer V1202. This stage receives two input signals, one at a frequency of 65-mc and the other at a frequency of 64-mc. The resultant beat signal at the output of the mixer is one megacycle. The output of the mixer is then fed to the 1-mc amplifier. The 65-mc input signal to the mixer is derived from the output of the 65-mc local oscillator and is fed to the suppressor grid of tube V1202. The 64-mc input signal to the mixer is derived from the output of the 64-mc i-f amplifier and is fed to the control grid of tube V1202 through a stepup transformer T1201. This transformer is used for matching the impedance of the 50-ohm cable which feeds the 64-mc signal from the 64-mc i-f amplifier to the transformer T1201. This transformer is tuned to 64-mc and, in addition, feeds a voltage to the tapping point on the cathode resistor in

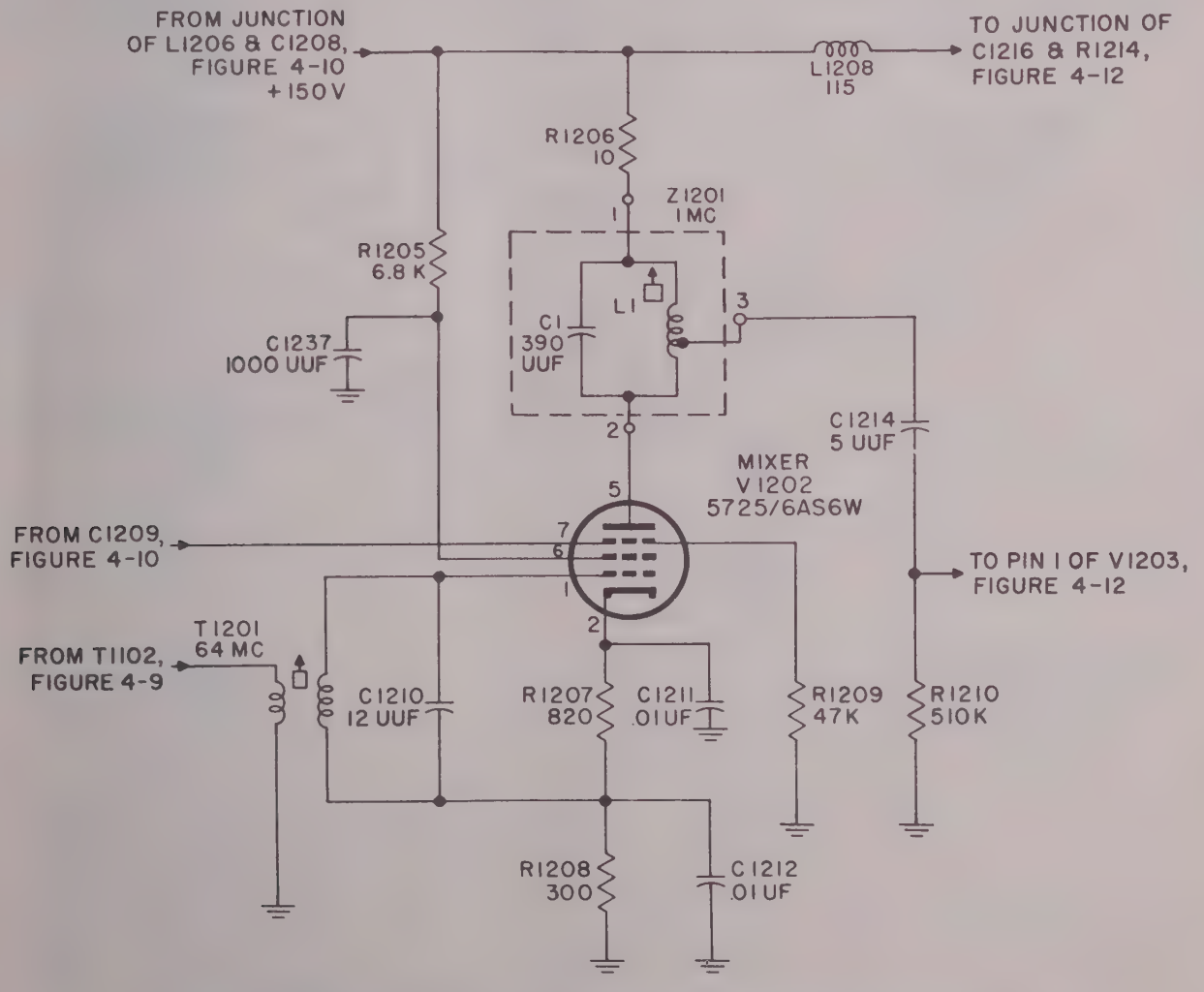


Figure 4-11. Mixer Stage V1202, 1-MC I-F Amplifier Simplified Schematic

order to provide proper bias to the tube for proper mixing. The plate circuit of this tube contains a tune circuit Z1201 tuned to one megacycle. The coil L1 of this tuned circuit is tapped in order to reduce the loading on the coil and increase the Q characteristic, thus giving better selectivity.

4-50. Shown in figure 4-12 is a simplified schematic of the 1-mc amplifier stage V1203. The 1-mc input signal to the amplifier is fed to the control grid of V1203. The amplified output signal appears in the tuned circuit Z1202, which is identical to the tuned circuit Z1201 in the mixer output stage, coil L1 in Z1202 also being tapped. The output signal of the amplifier is fed to a phase inverter through capacitor C1220.

4-51. Shown in figure 4-13 is a simplified schematic of the phase inverter stage V1204 and square law detector stage V1205. The output of the 1-mc amplifier stage V1203 is fed to the grid of the second half of phase inverter V1204. This inverter is of the cathode-coupled type. The input signal applied to the grid of the second half of the phase inverter is also fed to the grid of the first half of the inverter through resistors R1219 and R1215. The phase inverter stage produces two output signals which are 180 degrees out of phase. Each output signal is fed to the control grid of a square law detector. One output signal is fed to detector V1205 through capacitor C1223, while the other output signal is fed to detector V1206 through capacitor C1224. The test point TP1201 is provided in the cathode circuit of the inverter to permit tuning and selectivity measurements of the 1-mc amplifier unit to be made without the introduction of distortion from the square law detector.

4-52. The two square law detectors constitute a push-pull squaring circuit. The grids are driven push-pull, while the plates are connected in push-pull fashion. The result is that the odd-powered harmonics of the grid signal are cancelled out. In addition, the tubes permit the fourth power content of the fourth harmonic to be very low, leaving the d-c component and the square law component to remain. This circuit functions properly for pulse signals, but does not operate well over as wide a range for sine wave signals. However, all signals applied to the square law detectors are pulse signals due to the frequency-time domain conversion. The output of the last detector stage is fed to the video network in the power supply and video unit.

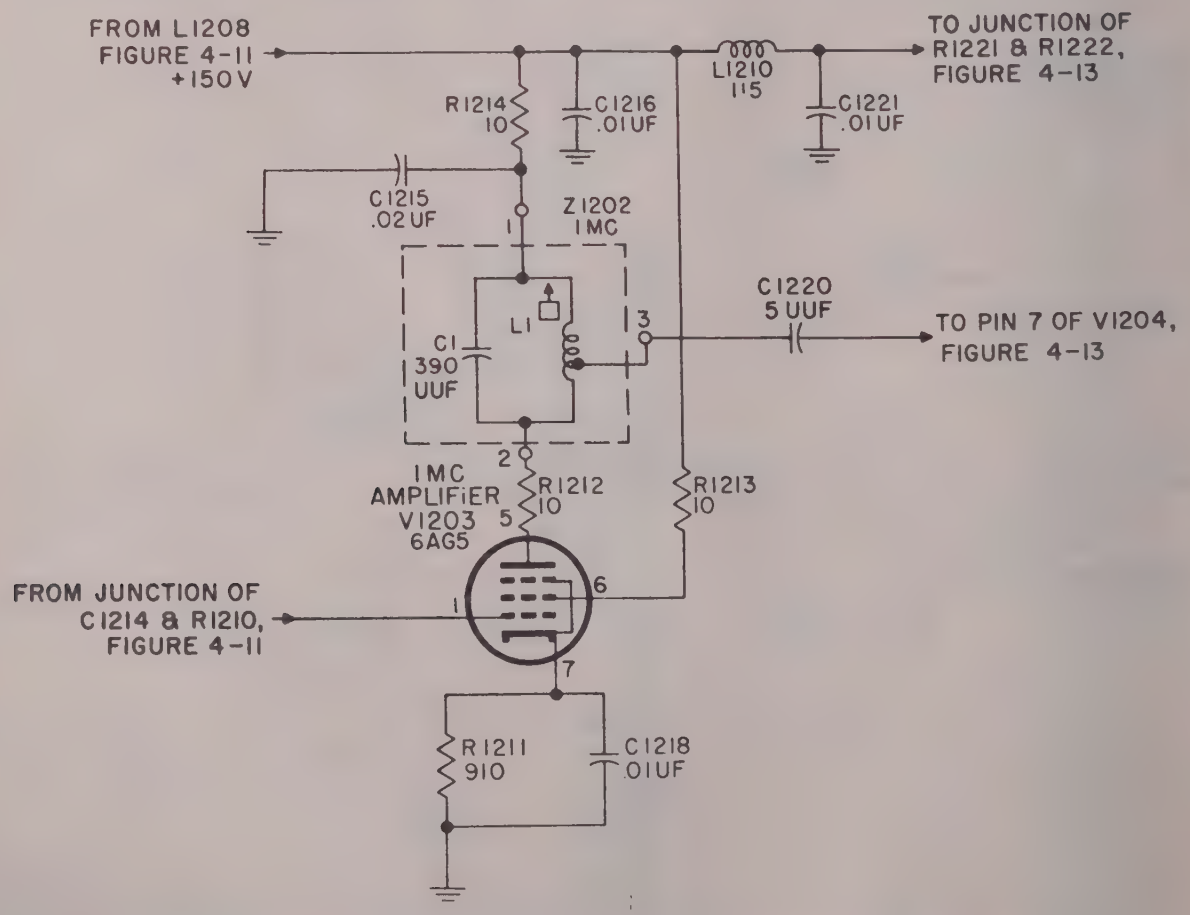


Figure 4-12. 1-MC Amplifier Stage V1203, 1-MC I-F Amplifier, Simplified Schematic

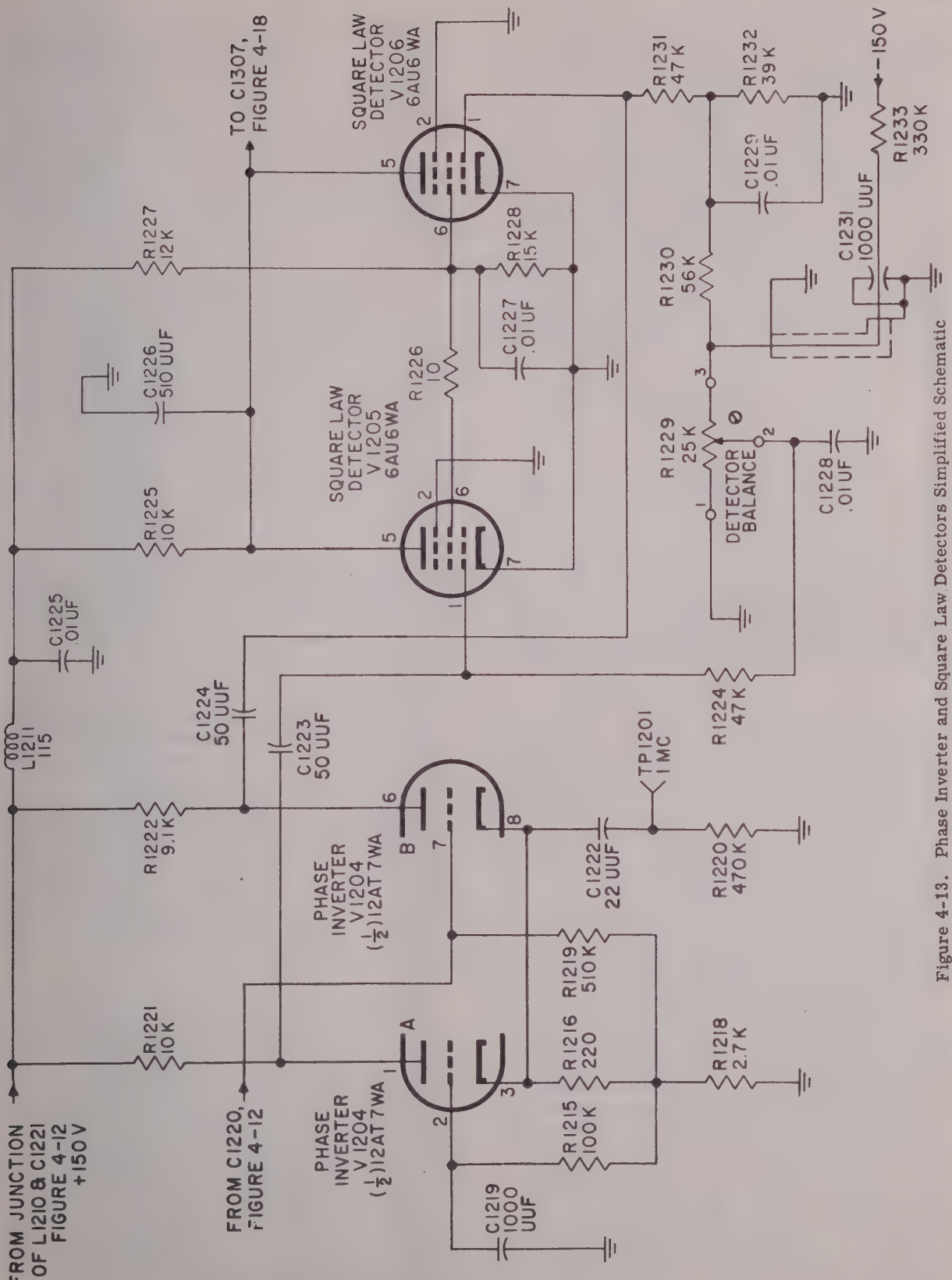


Figure 4-13. Phase Inverter and Square Law Detectors Simplified Schematic

4-53. The 6AU6 type of tube used in the squaring circuit possesses a peculiar grid-voltage, plate-current characteristic which makes it especially suitable for this squaring circuit. The screen and grid bias voltages for both 6AU6 tubes provide efficient square law operation. Variable resistor R1229 is the detector balancing potentiometer and is employed for matching one 6AU6 tube with the other. This is necessary because of the fine differences which exist between the 6AU6 tubes. Since the 6AU6 tube is a squaring amplifier, the signal in the plate circuit of the square law detector is two megacycles. This 2-mc signal, therefore, is much easier to filter. Capacitor C1226 performs the filtering action. The plate-load resistor R1225, which is 10,000 ohms, provides maximum square-law operation. The +150-volt and the -150-volt leads in the 1-mc i-f amplifier unit are well filtered to prevent interaction between this subassembly and other units.

4-54. SWEEP FREQUENCY GENERATOR.

4-55. The sweep frequency generator consists of four functional segments: the reactance modulated oscillator, two r-f amplifier stages, a frequency tripler and a frequency doubler. Shown in figure 4-14 is a simplified schematic of the reactance modulated oscillator. This segment consists of a reactance modulator stage V1501 and a frequency-modulated oscillator stage V1502. The reactance modulator is a pentode, type 6AK5, and the frequency modulated oscillator is a dual triode, type 12AT7, being cathode coupled. The basic center frequency of the reactance modulated oscillator is 37-1/3-mc.

4-56. The sawtooth signal from the sawtooth generator in the power supply and video unit is fed to the control grid of the modulator V1501 through resistor R1501. The -150-V d-c signal from the power supply unit is fed to the control grid of modulator V1501 through potentiometers R1017 and R1016A and resistor R1502. Potentiometers R1016B, R1018, R1017, and R1016A, control the fine and coarse centering of the spectrum display. The output of the modulator is fed to the grid of the first half of the dual triode V1502. The plate output of this half of the triode is fed back to the control grid of the reactance modulator through capacitor C1505 and resistor R1503. The output of the modulator is also fed to the grid of the second half of the dual triode V1502 through resistors R1510 and R1511. The plate output of the second half of the triode is fed to inductor L1504 which is the frequency controlling element of the oscillator. The frequency of the oscillator varies when the reactance across inductor L1504 is changed by the action of the reactance modulator. Inductor L1504 is tuned to 43-mc to insure sufficient linearity to exist over the prescribed frequency range (32.8 to 41.9 mc) of the oscillator. The output signal of the oscillator is then fed to a two-stage r-f amplifier.

4-57. The mutual conductance of the reactance modulator V1501 is varied by changing the negative bias voltage applied to the control grid. The bias is obtained from the "SPECTRUM CENTERING" controls. The controls are part of a bleeder circuit starting from -150 volts dc down to ground. A comparatively large voltage is introduced at the input of the sweep frequency generator, the voltage being divided by a voltage divider network consisting of resistors R1502 and R1504. Resistor R1504 is a large divider (47,000 ohms) and is necessary in order to provide isolation between the centering control and the sawtooth signal input so that one signal will not load the other. The dynamic deviation of the oscillator is obtained by introducing the sawtooth signal to the control grid of modulator V1501. Capacitor C1502 is a 1000-uuf, feed-through capacitor used to prevent the r-f signal from feeding out of the cable to the power supply unit.

4-58. Shown in figure 4-15 is a simplified schematic of the r-f amplifier section of the sweep frequency generator. Two stages of r-f amplification are employed. The output of the reactance modulated oscillator is fed to the control grid of the first r-f amplifier V1503 through capacitor C1512. The output of the first r-f amplifier is fed to the control grid of the second r-f amplifier V1504 through capacitor C1516. The output of the second r-f amplifier is fed to a frequency tripler which triples the frequency of the reactance modulated oscillator. The type 6AH6 tubes used provide maximum gain. These tubes are of high mutual conductance. The plate resistors R1516 and R1519 are anti-parasitic resistors. Amplifier V1504 operates in a grid-current region, that is, much of the bias is obtained from the grid-leak network. The values of the cathode resistors R1515 and R1518 insure that the ratings of the type 6AH6 tubes will never be exceeded when a signal is absent.

4-59. Shown in figure 4-16 is a simplified schematic of the frequency tripler-doubler segment of the sweep frequency generator. The frequency tripler V1505 and the doubler V1506 utilize a pentode type tube 6AK5. The amplified output of the r-f amplifier V1504 is fed to the control grid of the frequency tripler V1505. The tuned plate circuit Z1501 of V1505 is tuned to 112-mc. As a result, the signal from the reactance modulated oscillator is tripled and fed to the control grid of doubler V1506. The tuned plate circuit of V1506 is tuned to 224-mc. The frequency of the output signal of tripler V1505 is therefore doubled. The frequency-modulated output signal, centered about 224 megacycles, is then fed to mixer V1101 in the 64-mc i-f amplifier unit.

4-60. The frequency tripler V1505 operates under grid current conduction. Cathode resistor R1523 insures that the ratings of the tube will not be exceeded. The plate filter Z1501 is a double tuned network which is heavily loaded to give a large bandwidth. The frequency doubler V1506 also operates under grid current conduction, having only grid leak bias. This permits good sensitivity to result for the amount of output expected. The filter network in the output of V1506 possesses a bandwidth of 55-mc. This filter network matches the comparatively high output impedance of the 6AK5 tube to a 50-ohm cable. The filter is also used to compensate for various voltage changes in the oscillators, amplifiers, and frequency multipliers along the line so that the output of the sweep frequency generator is reasonably flat.

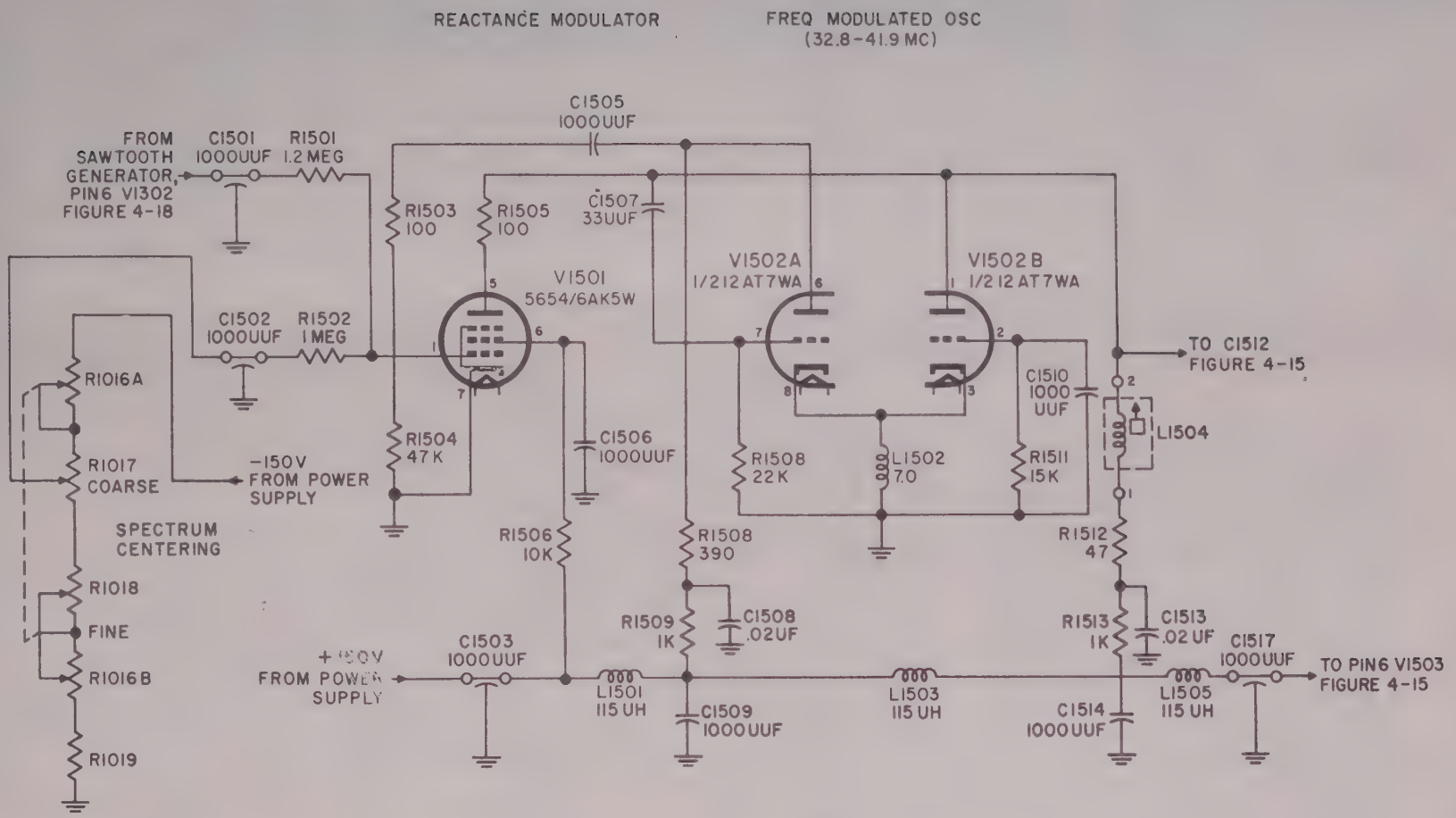


Figure 4-14. Reactance Modulated Oscillator, Sweep Frequency Generator Simplified Schematic

4-61. POWER SUPPLY AND VIDEO.

4-62. Shown in figure 4-17 is a simplified schematic of the power supply section of the power supply and video unit. When the "POWER" switch S1004 on the panel of the indicator drawer is on, the primary of transformer T1301 is excited with 115 volts ac. Transformer T1301 possesses three secondary windings which generate 190 volts, 160 volts, and 6.3 volts. The two selenium rectifiers CR1301 and CR1302 rectify the two 190-volt and 160-volt signals. The 150 volts dc produced at the output of the power supply is series regulated and amplified by amplifier V1312. Resistor R1361 is the +150-volts ADJUST control which is accessible on top of the power supply and video chassis. The +150-volt d-c signal is the plate voltage supplied to the 1-mc amplifier, the 64-mc amplifier, the spectrum calibrator, and the sweep frequency generator. The -150 volts dc produced at the output is regulated by regulator V1310. Resistor R1352 is the -150-volt ADJUST control which is accessible on top of the power supply and video chassis.

4-63. Shown in figure 4-18 is a simplified schematic of the video section of the power supply and video unit. The sawtooth generating circuits shown perform a dual purpose. The network modulates the sweep frequency generator, signal of 224-mc in the sweep frequency generator and deflects the cathode-ray beam. The multivibrater V1301 generates square wave pulses which are fed to the input of sweep generator V1302. The sawtooth output of the sweep generator is fed into sweep amplifier V1302 for signal amplification before being fed to the sweep frequency generator where the sawtooth voltage frequency modulates the 224-mc signal. A portion of the input to V1302 is fed to the grid of the first half of sweep amplifier V1303 through horizontal gain control R1317. The output of sweep amplifier V1303 is fed to the horizontal deflection plates of the cathode-ray tube. The video output from the 1-mc i-f amplifier is impressed upon the grid of the first half of video amplifier V1304. After video amplification, the output signal from V1304 is d-c restored by V1307, the grid and plate of which are tied together to form a diode. The restored signal is further amplified by V1305 before being fed to the vertical plates of the cathode-ray tube.

4-64. Note that a portion of the output of the first half of video amplifier V1305 is fed to the control grid of the intensifier squaring tube V1306. The outpur of V1306 is amplified by V1307, the intensifier amplifier. The output of V1307, adjustable by intensifier control R1341, is then fed to the focus electrode of the cathode-ray tube, the intensifier network is incorporated to permit brightening of the trace on the scope screen so that the short transient of the r-f pulse presented can be clearly viewed. To intensify the trace and, at the same time, preserve optimum focus, the out-of-phase signal from V1307 is simultaneously applied to the focus electrode.

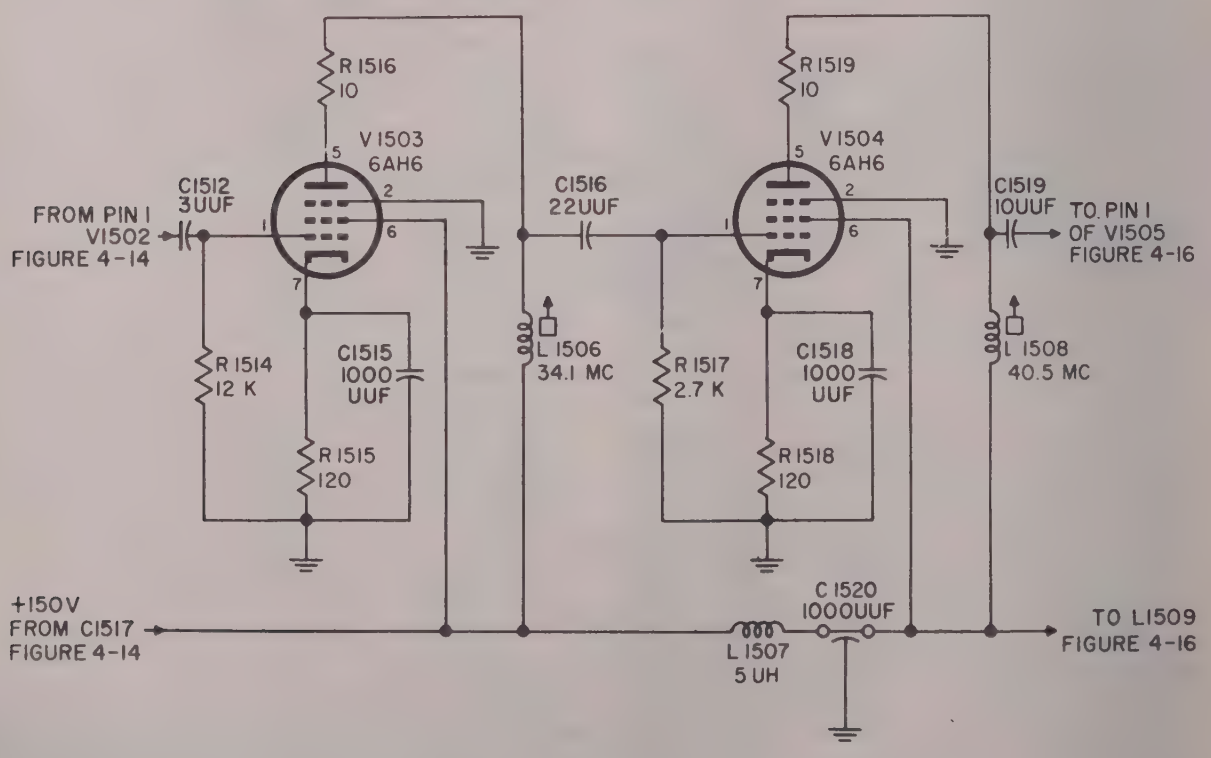


Figure 4-15. R-F Amplifier, Sweep Frequency Generator Simplified Schematic

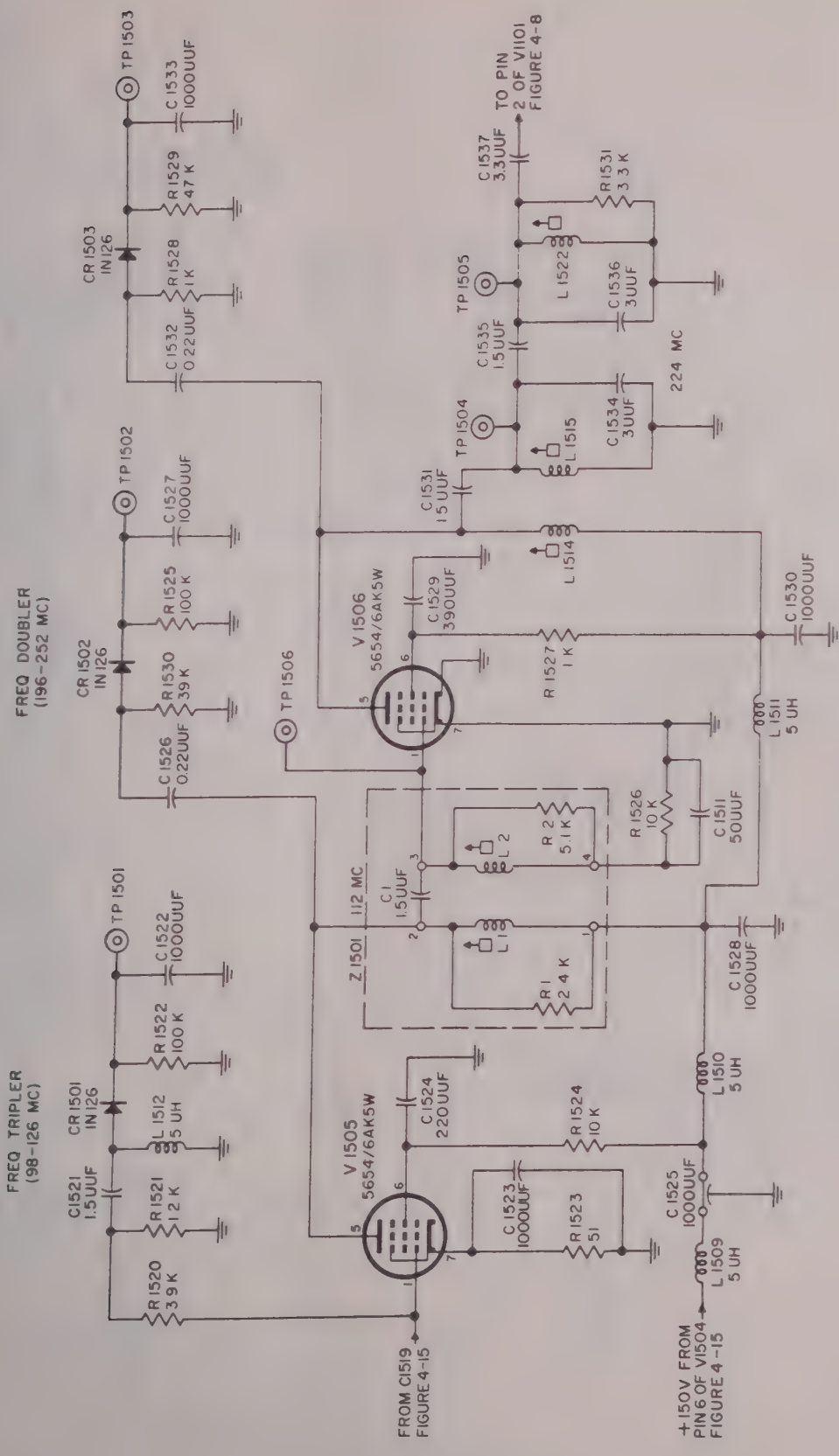


Figure 4-16. Frequency Tripler and Doubler Simplified Schematic

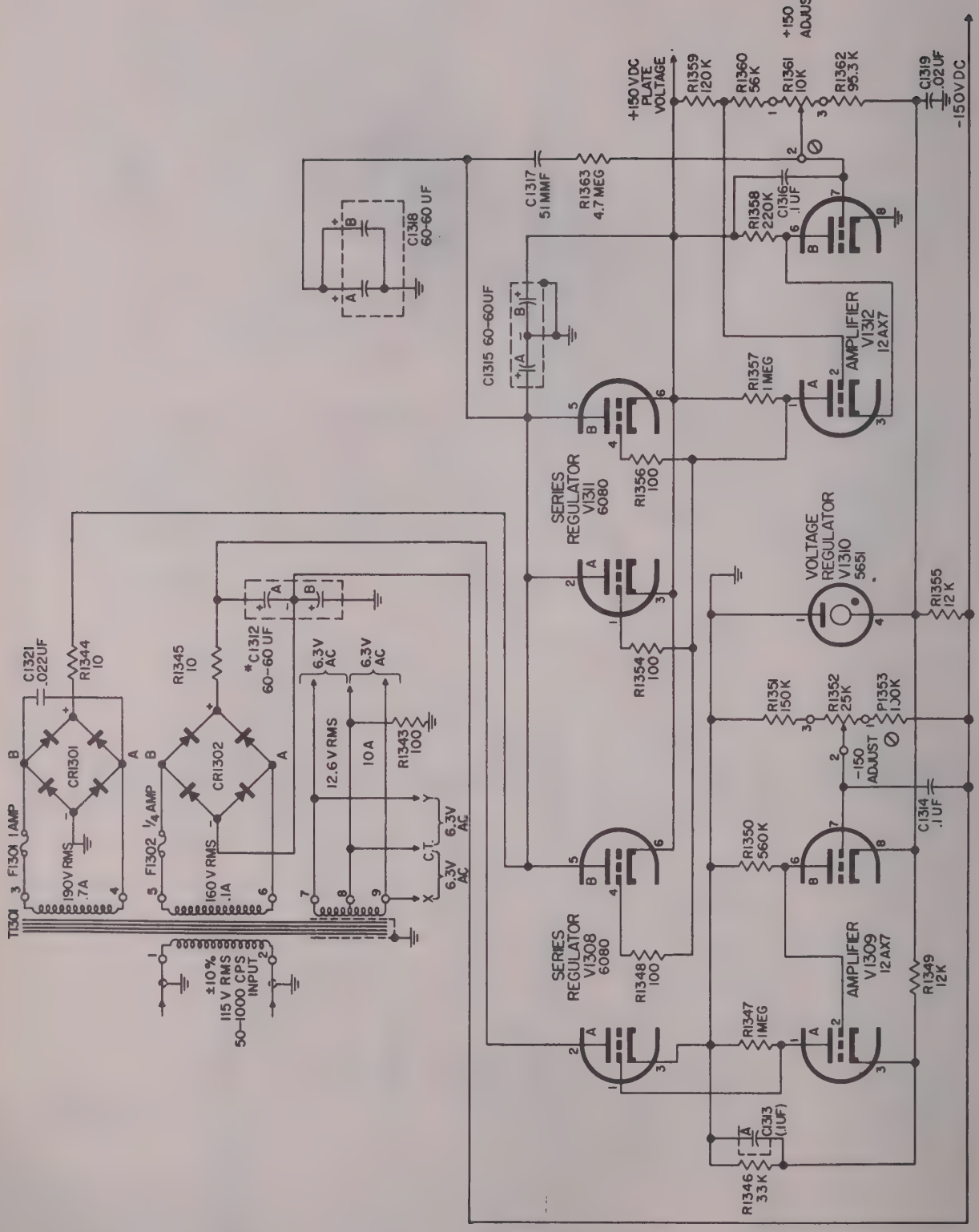


Figure 4-17. Power Supply Simplified Schematic

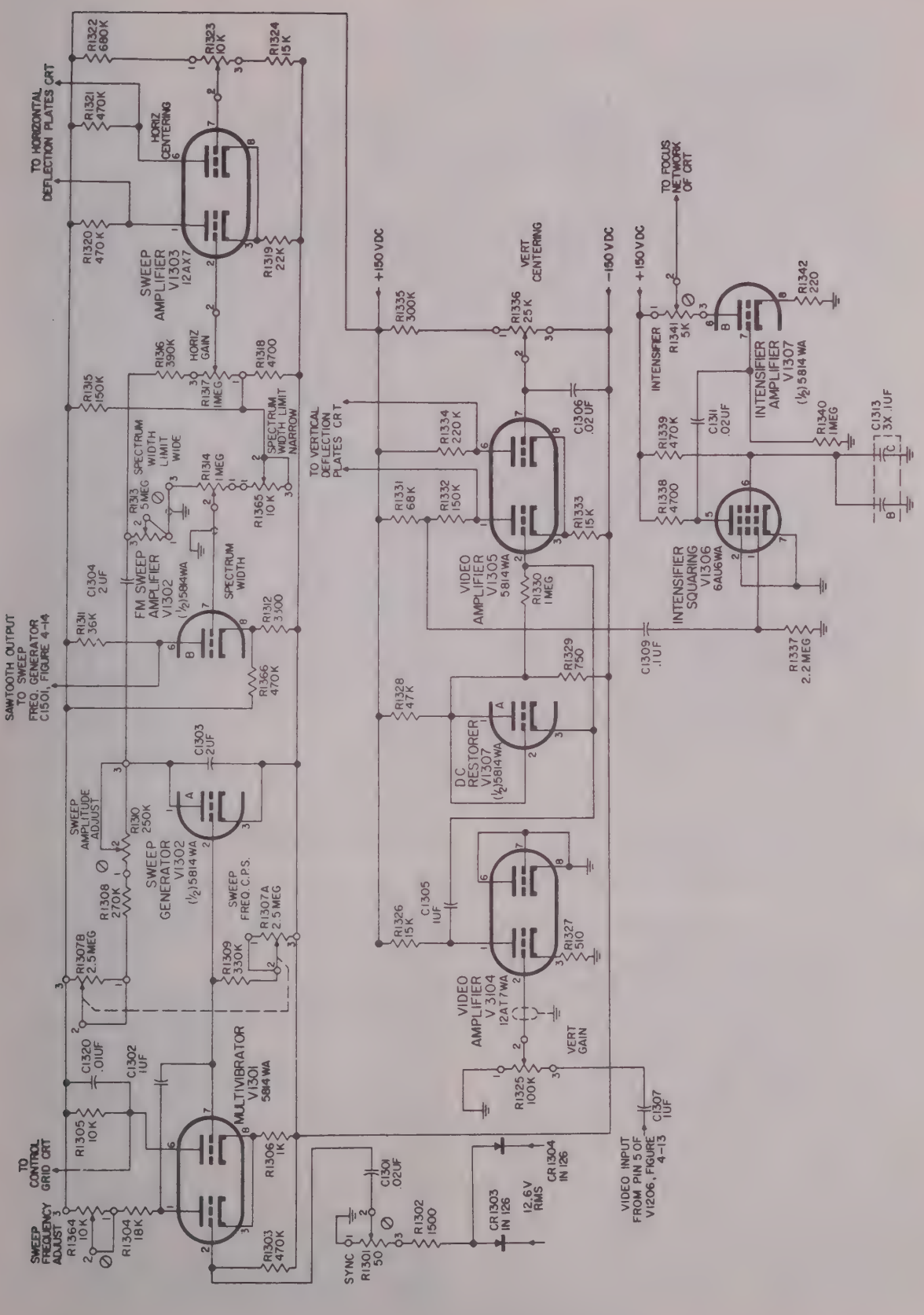


Figure 4-18. Video Section Simplified Schematic

SECTION V

ORGANIZATIONAL MAINTENANCE

WARNING

Operation of this equipment involves the use of high voltages which are dangerous to life. Maintenance personnel must at all times observe all safety precautions. Always turn off all power before performing internal inspection or maintenance work on this equipment.

5-1. GENERAL.

5-2. This section details the procedures for checking and adjusting the spectrum analyzer at the using organization. Owing to the complex circuits employed in the unit, the procedures described are limited to the capabilities of the personnel and to the available test equipment. For more detailed information, reference may be made to paragraph 6-1 through 6-28 of this handbook.

5-3. MINIMUM PERFORMANCE STANDARDS.

5-4. PLATE VOLTAGE SUPPLY. Check and adjust the plate voltage supply in the indicator unit (figure 5-1) using the following procedure:

a. Connect the power cord into a power supply of 115 volts, 50 to 1000 cps ac.

b. Place the "POWER" switch (12, figure 5-1) on. The power indicator lamp (13, figure 5-1) must light.

c. Rotate the "METER SELECTOR" switch (22, figure 5-1) to the "LINE VOLTS" position. The voltage reading on the voltmeter (23, figure 5-1) must be approximately 115 volts.

d. Rotate the "METER SELECTOR" switch (22, figure 5-1) to the "+150 V" position. The voltage reading on the voltmeter (23, figure 5-1) must be 150 volts plus or minus 1 volt. If the reading does not fall within tolerance, follow the instructions given in steps f and g of this paragraph for an additional check and the necessary adjustments to be made.

e. Rotate the "METER SELECTOR" switch (22, figure 5-1) to the "-150 V" position. The voltage reading on the voltmeter (23, figure 5-1) must be 150 volts plus or minus 1 volt. If the reading does not fall within tolerance, follow the instructions given in steps f and g of this paragraph for an additional check and the necessary adjustments to be made.

f. Loosen the 15 panel screws (31, figure 5-1) on the indicator unit and slide the drawer forward. Remove the top cover of the drawer to gain access to the top of the power supply chassis (figure 5-2). Place the positive test lead of a suitable voltmeter into the +150-volt jack, test point 5 (figure 5-2) colored red, on top of the power supply chassis. Place the negative test lead of the voltmeter to chassis ground. Observe the voltmeter reading. If the reading varies considerably from 150 volts, potentiometer R1361 (figure 5-2) requires adjustment as given in step g of this paragraph. Place the negative test lead of the voltmeter into the -150-volt jack, test point 6 (figure 5-2) colored white, and the positive test lead to chassis ground. Observe the voltmeter reading. If the reading varies considerably from 150 volts, potentiometer R1352 (figure 5-2) requires adjustment as given in step g of this paragraph.

g. Remove the voltmeter from the test jacks. Place the "METER SELECTOR" switch (22, figure 5-1) in the "+150 V" position and adjust R1361 (figure 5-2) until the voltmeter (23, figure 5-1) on the indicator unit panel reads 150 volts. Place the "METER SELECTOR" switch (22, figure 5-1) in the "-150 V" position and adjust R1352 (figure 5-2) until the voltmeter (23, figure 5-1) reads 150 volts.

h. Replace and secure the top cover of the indicator drawer. Slide the drawer into the instrument case and tighten all panel screws.

5-5. SPECTRUM CENTERING. If the spectra received on the scope screen cannot be properly centered by using the "SPECTRUM CENTERING" controls (9 and 10, figure 5-1), perform the following procedure to correct:

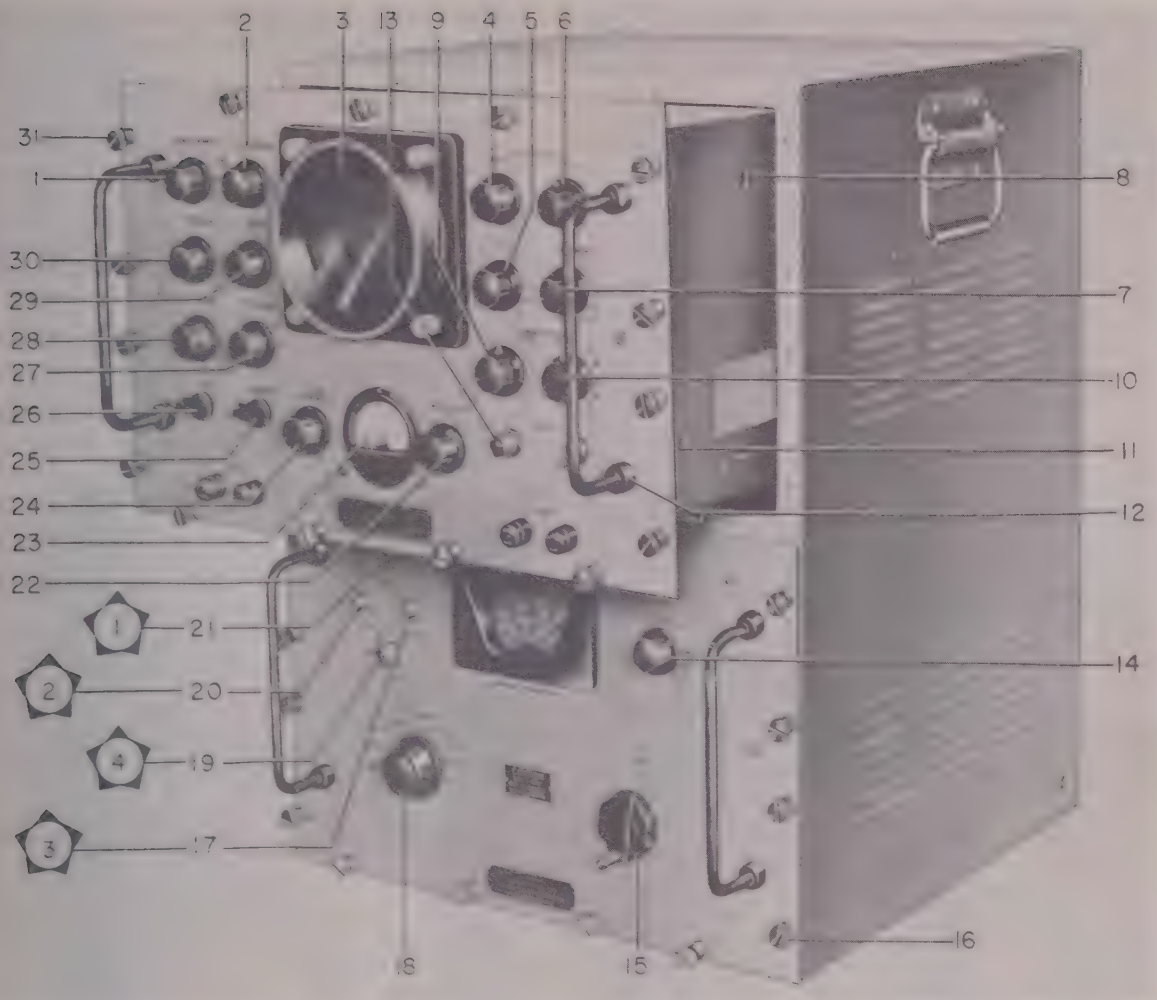
a. Loosen the 15 panel screws (31, figure 5-1), and slide the indicator drawer forward.

b. Set the "SPECTRUM CENTERING" "COARSE" and "FINE" controls (9 and 10, figure 5-1) to their zero positions. Adjust potentiometer R1016 (11, figure 5-1) until the centering is restored on the scope screen. Allow setting to remain.

c. Carefully slide the drawer into the instrument case and secure all indicator panel screws.

5-6. SPECTRUM WIDTH. If the full 25-mc sweep cannot be obtained by using the "SPECTRUM WIDTH" control (27, figure 5-1), perform the following procedure to restore the full range:

a. Loosen the 15 panel screws (31, figure 5-1) and slide the indicator drawer forward. Remove the top cover of the drawer to gain access to the power supply chassis (figure 5-2).



1. "HORIZ CENTERING" knob
2. "VERT CENTERING" knob
3. Scope Screen
4. "SPECTRUM CALIBRATOR" - "AMPLITUDE" knob
5. "FOCUS" knob
6. "SPECTRUM CALIBRATOR" - "FREQUENCY" knob
7. "BRIGHTNESS" knob
8. C1404 adjustment
9. "SPECTRUM CENTERING" - "COARSE" knob
10. "SPECTRUM CENTERING" - "FINE" knob
11. R1016 adjustment
12. "POWER" switch
13. "POWER" indicator lamp
14. "IF ATTENUATION-DB"
15. "TUNE" control
16. R-F tuner unit panel screw
17. "350-1000"
18. "BAND SELECTOR" switch
19. "1000-16000"
20. "150-350"
21. "10-150"
22. "METER SELECTOR" switch
23. Voltmeter indicator
24. "SCALE ILLUMINATION" knob
25. "INTENSIFIER" control
26. "SYNC" control
27. "SPECTRUM WIDTH" knob
28. "SWEEP FREQ" knob
29. "VERT GAIN" knob
30. "HORIZ GAIN" knob
31. Indicator unit panel screw

Figure 5-1. Spectrum Analyzer, Three-Quarter View

b. Set the "SPECTRUM WIDTH" control (27, figure 5-1) to "25" and adjust potentiometer R1313 (figure 5-2) until the full range of the 25-mc sweep is restored on the scope screen.

c. Replace and secure the top cover of the indicator drawer. Slide the drawer into the instrument case and tighten all panel screws.

5-7. INSPECTION.

5-8. Perform the following inspections:

a. Visually examine the exterior of the unit. Check that all switches, knobs and fuse holders are securely tightened. Check all switches and controls for smoothness of operation. Make sure that no corrosion is present. Clean and dust the exterior with a dry lint-free cloth.

b. Loosen the 15 panel screws (31, figure 5-1) and slide the indicator drawer forward. Remove the top cover of the drawer. Check that all components are clean, secure, and free from corrosion or pitting. Replace the top cover and carefully slide the drawer into the instrument case. Tighten all panel screws.

c. Loosen the 15 panel screws (16, figure 5-1) and

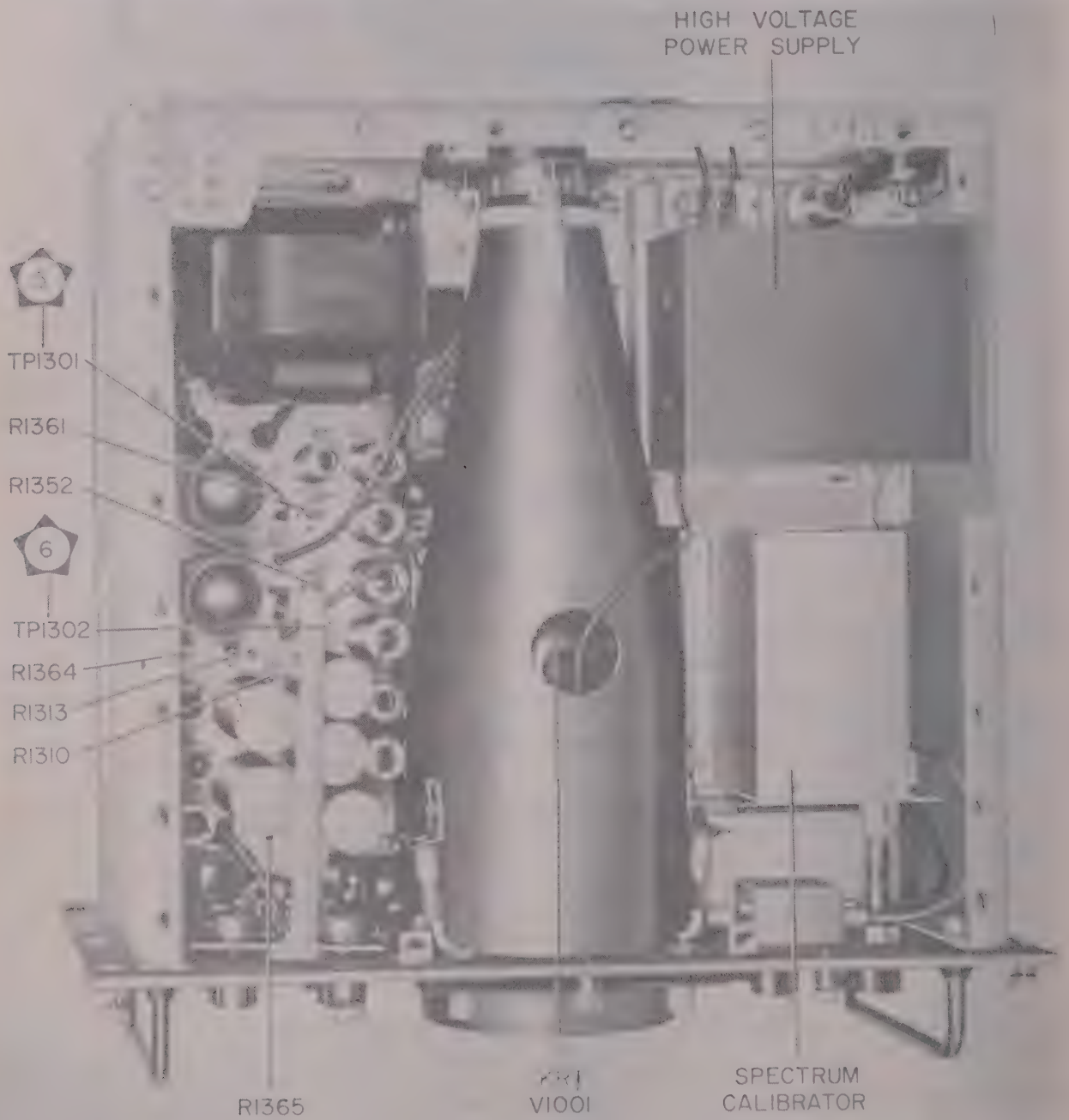


Figure 5-2. Pulse Analyzer Indicator, Top View

slide the r-f tuner-drawer forward. Remove the top cover of the drawer. Check that all components are clean, secure, and free from corrosion or pitting. Carefully check that all cable connections are firmly connected. Replace the top cover and carefully slide the drawer into the instrument case. Tighten all panel screws.

CAUTION

Exercise care while making the above inspection. Many of the mechanical parts are adjusted to critical tolerances.

5-9. INSPECTION SCHEDULE. Listed in table VIII are the components, inspections, and time intervals to be used by the operating activity. References in the inspection column of the table refer to paragraphs in this section where the details of the procedure for each inspection will be found.

TABLE VIII. INSPECTION SCHEDULE

COMPONENT	INSPECTION	TIME
Spectrum Analyzer AN/UPM-17	Refer to paragraph 5-8a.	Daily
R-F Tuner TN-188/UPM	Refer to paragraph 5-8c.	25 hr.
Pulse Analyzer Indicator IP-130/UPM-17	Refer to paragraph 5-8b.	25 hr.
	Refer to paragraphs 5-4, 5-5, and 5-6.	50 hr.

5-10. MINOR REPAIR AND ADJUSTMENTS.

NOTE

Replace an old part in its proper position in the equipment if substitution of a new part does not correct the trouble. Do not leave a replacement part in the test set if it does not remedy the trouble.

5-11. TUBE REPLACEMENT. When replacing a defective tube with a new one, refer to the adjustment procedure for the associated circuit given in paragraphs 6-1 through 6-28.

5-12. FUSE REPLACEMENT. Check the continuity of the suspected fuses with a multimeter. Replace defective fuses with their spares. Provide new spares as soon as possible. Fuse holders may be removed by a one-quarter turn counterclockwise, and then withdrawing. Replace fuseholders by inserting firmly into the sockets, and then turning clockwise one-quarter turn.

5-13. INDICATOR LAMP REPLACEMENT. Check continuity of the suspected lamp with a multimeter. Replace defective lamp with a similar type.

SECTION VI

FIELD MAINTENANCE

WARNING

Operation of this equipment involves the use of high voltages which are dangerous to life. Maintenance personnel must at all times observe all safety precautions. Always turn off all power before performing internal inspection or maintenance work on this equipment.

6-1. GENERAL.

6-2. This section provides instructions for making adjustments, alignment, trouble shooting and necessary replacements to be performed by field maintenance personnel. Any further detailed information may be found in the latest issue of the applicable Handbook of Overhaul Instructions.

CAUTION

Extreme care must be used to protect the equipment and test instruments from damage while making all tests.

6-3. MINIMUM PERFORMANCE STANDARDS.

6-4. The tests, indications and adjustments required for minimum performance of the analyzer are listed in paragraph 6-5 through 6-22. When an abnormal indication is obtained, and an adjustment cannot correct the condition, refer to paragraph 6-23.

NOTE

If the test equipment mentioned in the following procedures are not available, equivalent test equipment may be used.

6-5. TEST EQUIPMENT REQUIRED. Refer to table VII for the test equipment required to perform the following checks.

6-6. PRELIMINARY PROCEDURE.
a. Connect the analyzer power cord to the Variac and the AN/PSM-3 voltmeter.
b. Connect the Variac to an external supply of 115 volts, 50 to 1000 cps, ac.
c. Adjust the Variac to indicate 115 volts on the AN/-PSM-3.

6-7. HIGH VOLTAGE POWER SUPPLY.
a. Using a Simpson Model 260 (250 volt scale), check the d-c voltage at test points 7 and 8 (figure 6-1). Multiply the meter reading by nine. The acceptable values are listed in table IX.
b. Using a Ballantine Model 300, check the ripple voltage present at test point 7 and test point 8. The acceptable values are given in table IX.

6-8. POWER SUPPLY.
a. Using a Simpson Model 260, check the d-c voltage present at test points 5 and 6 (figure 5-2). The acceptable values are given in table IX. If the indication is abnormal, adjust R1361 (figure 5-2) for test point 5, and R1352 (figure 5-2) for test point 6.
b. Using a Ballantine Model 300, check the ripple voltage at test point 5 and test point 6. The acceptable values are given in table IX.

TABLE IX. VOLTAGE CHECKS

TEST POINT	VOLTAGE AND TOLERANCE	RIPPLE TOLERANCE
(7) TP1601	+1500 ±100 volts	Less than 1.5 volts
(8) TP1602	-1500 ±100 volts	Less than 1.5 volts
(5) TP1301	±150 ±1 volt	Less than 20 uv
(6) TP1302	-150 ±1 volt	Less than 20 uv

6-9. LINEARITY.
a. Connect a Hewlett Packard Model 608 to test point A (figure 6-1). Set the Model 608 output to 64-mc at 1000-cps, 30% modulation.
b. Adjust R1310 (figure 5-2) for an evenly spaced pattern on the scope screen.
c. Adjust R1001 (figure 6-1) and vary the "FOCUS" control for a clear-sharp signal across the spectrum.

6-10. NOISE LEVEL.
a. Adjust peaking coil T1201 (figure 6-1) for maximum amplitude of noise.
b. Set the "VERT GAIN" knob (29, figure 5-1) at maximum, fully clockwise.
c. Adjust R1112 (figure 6-1) for approximately 1/4-cm average of noise.
d. Set the "VERT GAIN" knob between "3" and "4". The noise level should be barely perceptible.

6-11. SWEEP FREQUENCY.
a. Set the "SWEEP FREQ" knob (28, figure 5-1) to "30".
b. Disconnect cable plug P1303 (figure 6-1) from test point B (J1202) and connect plug P1303 to the output of a Hewlett Packard Model 200c to 30 cps.
c. Adjust the "SWEEP FREQ" knob (28, figure 5-1) to obtain a single sine-wave indication on the scope screen. If this cannot be obtained, adjust R1364

(figure 5-2) and the "SWEEP FREQ" knob, respectively, until a single sine-wave indication is observed.
d. Loosen the "SWEEP FREQ" knob and set the knob to read "30"; tighten knob.
e. Check the "SWEEP FREQ" knob at "25" and "20", varying the Model 200c output accordingly. Refer to step c to calibrate the "SWEEP FREQ" dial at these positions.

6-12. VIDEO AMPLIFIER.
a. Connect a Ballantine Model 300 to the Hewlett Packard Model 200c output.
b. Connect the Model 200c to P1303 (figure 6-1) as given in step 5-11b.
c. Set the Model 300 on the 1-volt scale and the gain on the Model 200c to 16 on the db scale.
d. Set the "INTENSIFIER" (25, figure 5-1) fully counterclockwise; "VERT GAIN" knob (29, figure 5-1) to obtain 5-cm deflection of signal.

NOTE

Do not change this setting throughout the test procedure.

e. Vary the Model 200c gain control to obtain a 5-cm deflection of signal on the scope screen for each of the following frequencies: 20 cps, 60 cps, 100 cps, 300 cps, 500 cps, 700 cps, 1 kc, 3 kc, 5 kc, and 8 kc. The reading on the Model 300 must be flat within 2 db.

6-13. SPECTRUM CALIBRATOR.
a. Connect an FR-6 at 160-mc to test point 1 (21, figure 5-1).
b. Set the "AMPLITUDE" knob (4, figure 5-1) of the "SPECTRUM CALIBRATOR" to obtain 3-cm deflection of signal on the scope screen.
c. Zero-beat the "SPECTRUM "CALIBRATOR" against the 160-mc input by varying the "FREQUENCY" knob (6, figure 5-1).
d. Loosen the "FREQUENCY" knob and set it to "O". If this adjustment does not permit full range of the control, adjust the shaft.
e. Set the "SPECTRUM WIDTH" knob at minimum width.
f. Adjust R1016 (11, figure 5-1) to bring the indication in the center.
g. Zero-beat the signal from the FR-6 against the calibrator signal for the following frequencies by

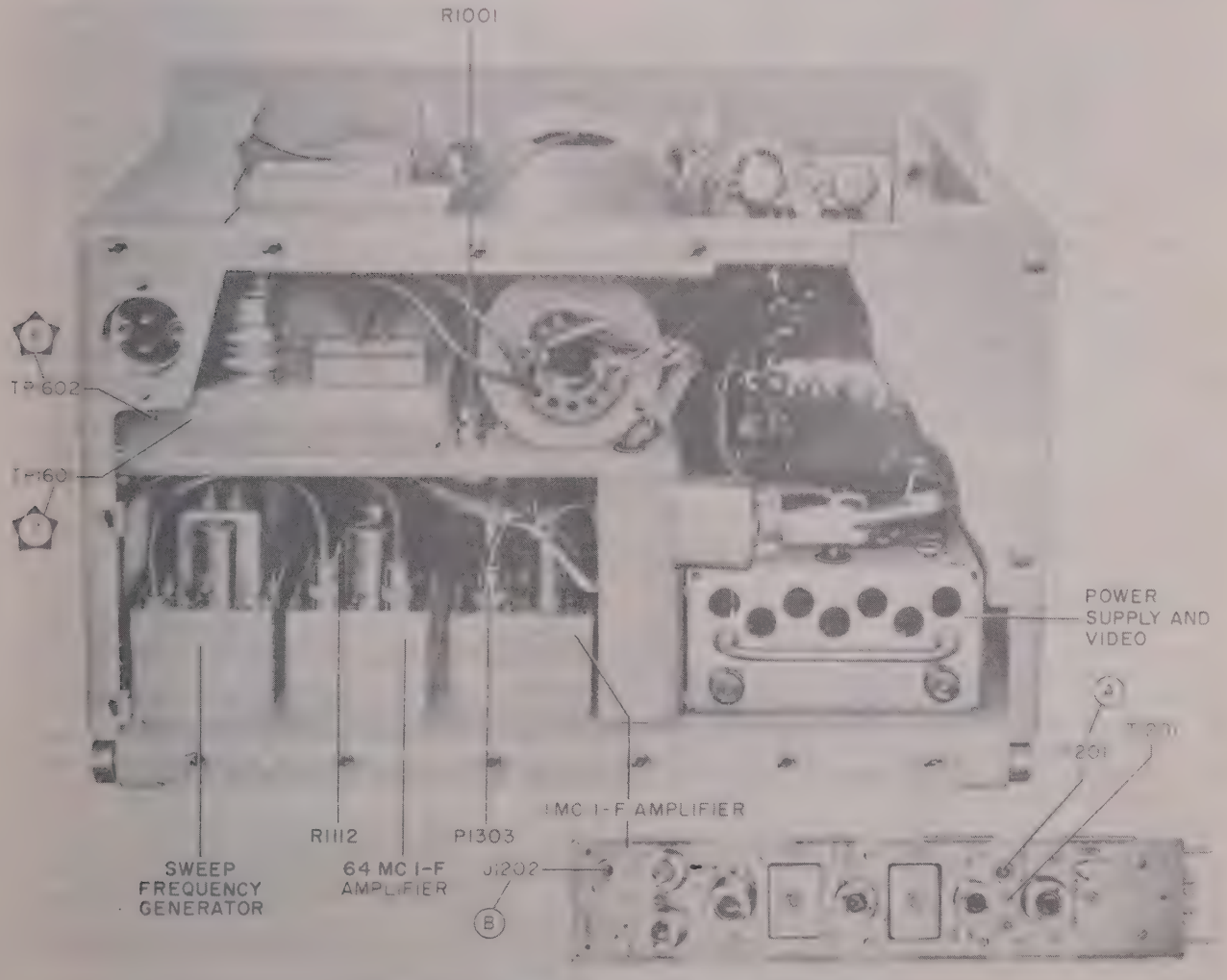


Figure 6-1. Pulse Analyzer Indicator, Rear View

varying the "FREQUENCY" knob (6, figure 5-1) above and below the 160-mc ("0") setting: 145 mc, 150 mc, 155 mc, 160 mc, 165 mc, 170 mc, and 175 mc. The calibrator frequency must be within ±0.5 mc.

6-14. SPECTRUM WIDTH.

a. Connect an FR-6 to test point 1 (21, figure 5-1).
b. Set the "FREQUENCY" knob (6, figure 5-1) to "0" (160 mc); "AMPLITUDE" knob (4, figure 5-1) to obtain 3-cm deflection of signal on the scope screen; "SPECTRUM WIDTH" knob (27, figure 5-1) at minimum width.

NOTE

Use this signal as a marker. Keep the signal on zero by varying the "SPECTRUM CENTERING" knob (10, figure 5-1).

c. Vary the signal from the FR-6 to one end of the trace (5-cm mark) and then to the other end of the trace (5-cm mark), recording the frequency reading at each end. Subtract the lower reading from the higher reading to obtain the bandwidth reading.
d. Repeat step c for all "SPECTRUM WIDTH" dial settings (1, 2, 3, 4, 5, 6, 10, 15, 20, and 25). The full range of the "SPECTRUM WIDTH" knob must not be less than 450 kc, nor more than 28 mc.
e. Adjust R1365 (figure 5-2) to calibrate the low end of the dial, and R1313 (figure 5-2) to calibrate the high end of the dial. If necessary, the "SPECTRUM WIDTH" knob may be reset.

6-15. 160-MC I-F ATTENUATOR.

a. Connect a Hewlett Packard Model 608 signal generator to test point 1 (21, figure 5-1).
b. Set the "BAND SELECTOR" switch (18, figure 5-1) to the "10-150 MCS WIDE" position; "IF ATTENUATION - DB" switch (14, figure 5-1) to "0".
c. Set the signal generator to 160-mc, cw. Set the attenuator control of the signal generator to obtain 5-cm deflection of signal on the scope screen.
d. Record the attenuator reading of the signal generator in db.
e. Set the "IF ATTENUATION - DB" switch to "54".
f. Set the attenuator control of the signal generator 54 db above step d.
g. Adjust R2022 (figure 6-2) to obtain 5-cm deflection of signal.
h. Set the "IF-ATTENUATION - DB" switch to "36".
i. Set the attenuator control of the signal generator 36 db above step d.
j. Adjust R2014 (figure 6-2) to obtain 5-cm deflection of signal.
k. Set the "IF ATTENUATION - DB" switch to "24".
l. Set the attenuator control of the signal generator 24 db above step d.
m. Adjust R2001 (figure 6-2) to obtain 5-cm deflection of signal.
n. Set the "BAND SELECTOR" switch (18, figure 5-1) to the "10-150 NARROW" position; "IF ATTENUATION - DB" switch (14, figure 5-1) to "0".
o. Set the attenuator control of the signal generator to obtain 5-cm deflection of signal on the scope screen.
p. Record the attenuator reading of the signal generator in db.
q. Set the "IF ATTENUATION - DB" switch to "54".
r. Set the attenuator control of the signal generator 54 db above step p.
s. Adjust R2023 (figure 6-2) to obtain 5-cm deflection of signal.
t. Set the "IF ATTENUATION - DB" switch to "36".
u. Set the attenuator control of the signal generator 36 db above step p.
v. Adjust R2015 (figure 6-2) to obtain 5-cm deflection of signal.
w. Set the "IF ATTENUATION - DB" switch to "24".
x. Set the attenuator control of the signal generator 24 db above step p.
y. Adjust R2004 (figure 6-2) to obtain 5-cm deflection of signal.
z. Check "IF ATTENUATION - DB" switch in the "6," "12," "18," "30," "42," "48," and "60" positions with "BAND SELECTOR" switch in the "10-150 WIDE" and the "10-150 NARROW" positions, successively. The readings must be within ±1 db.

6-16. AMPLITUDE COMPARATOR.

NOTE

The following procedure is also used as a response check for the 160-mc i-f.

a. Set the "FREQUENCY" knob (6, figure 5-1) to "0" (160 mc).
b. Set the "VERT GAIN" knob (29, figure 5-1) to "2". Set the "AMPLITUDE" knob (4, figure 5-1) to obtain between 3- and 4-cm deflection of signal (record this reading).

NOTE

Do not change the settings in step b throughout the procedures given in this paragraph.

c. Disconnect the calibrator cable from test point C (figure 6-2). Connect a Hewlett Packard Model 608 signal generator to test point C (J2009).
d. Set the signal generator to 160 mc and adjust the attenuator of the signal generator to obtain the same deflection in cm as that obtained with the spectrum calibrator input.
e. Record the attenuator reading of the signal generator in db as the input level for this frequency.
f. Disconnect the signal generator from test point C. Connect the calibrator cable to test point C.
g. Set the "FREQUENCY" knob (6, figure 5-1) and the signal generator in step d to 147.5 mc, 150 mc, 155 mc, 160 mc, 165 mc, 170 mc, and 172.5 mc, respectively. Record the input level at each point by repeating steps c through f.
h. Use an insulated screw driver and adjust C1404 (8, figure 5-1) to obtain a flat signal, within 2 db, from the spectrum calibrator from 147.5 to 172.5 mc.

6-17. SWEEP FREQUENCY LINEARITY.

a. Set the "SPECTRUM WIDTH" knob (27, figure 5-1) to "25"; "AMPLITUDE" knob (4, figure 5-1) to "OFF"; "VERT GAIN" knob (29, figure 5-1) between "3" and "4".
b. Connect two FR-6 frequency meters in parallel to test point 1 (21, figure 5-1).
c. Set one FR-6 to 160-mc. Use this signal to monitor the center frequency (160 mc) to eliminate drift that

might occur during the test.

d. Set the second FR-6 to 147.5 mc so that a marker appears at the margin of the screen. Shift the frequency of the FR-6 in 2.5-mc steps to 172.5 mc. Markers 2.5 mc apart should appear evenly spaced at each cm across the trace.

6-18. VIDEO DETECTOR.

a. Set the "VERT GAIN" knob (29, figure 5-1) to "10".

b. Set the "SPECTRUM WIDTH" knob (27, figure 5-1) to "1".

c. Connect a Hewlett Packard Model 608 to test point 1 (21, figure 5-1). Set the signal generator to 160 mc, cw.

d. Record the attenuator reading of the signal generator at each check point (1-cm, 2-cm, 3-cm, 4-cm, and 5-cm deflection of signal) on the scope screen.

e. The reading for 1-cm deflection of signal may be any value. The reading for 4-cm deflection of signal must be twice the amount $\pm$.15 microvolts than that obtained with 1-cm deflection of signal.

f. Repeat steps b through e for the following settings of the "VERT GAIN" knob (29, figure 5-1), "6" and "2".

6-19. HORIZONTAL AMPLIFIER LINEARITY.

a. Disconnect cable plug P1303 from test point B (figure 6-1).

b. Connect cable plug P1303 to the output jack of pulse generator TS592/U.

c. Set the "SWEEP FREQ" knob (28, figure 5-1) to "30"; "VERT GAIN" knob (29, figure 5-1) between "3" and "4"; "SPECTRUM WIDTH" knob (27, figure 5-1) to "25".

d. Set the oscillator frequency dial on the pulse generator to 330 cps; coarse attenuator to 20-200 output; selector to negative narrow; sync selector to 200-2000-cps range.

e. Check the trace on the scope screen. A pulse must appear at each cm $\pm$0.5 cm.

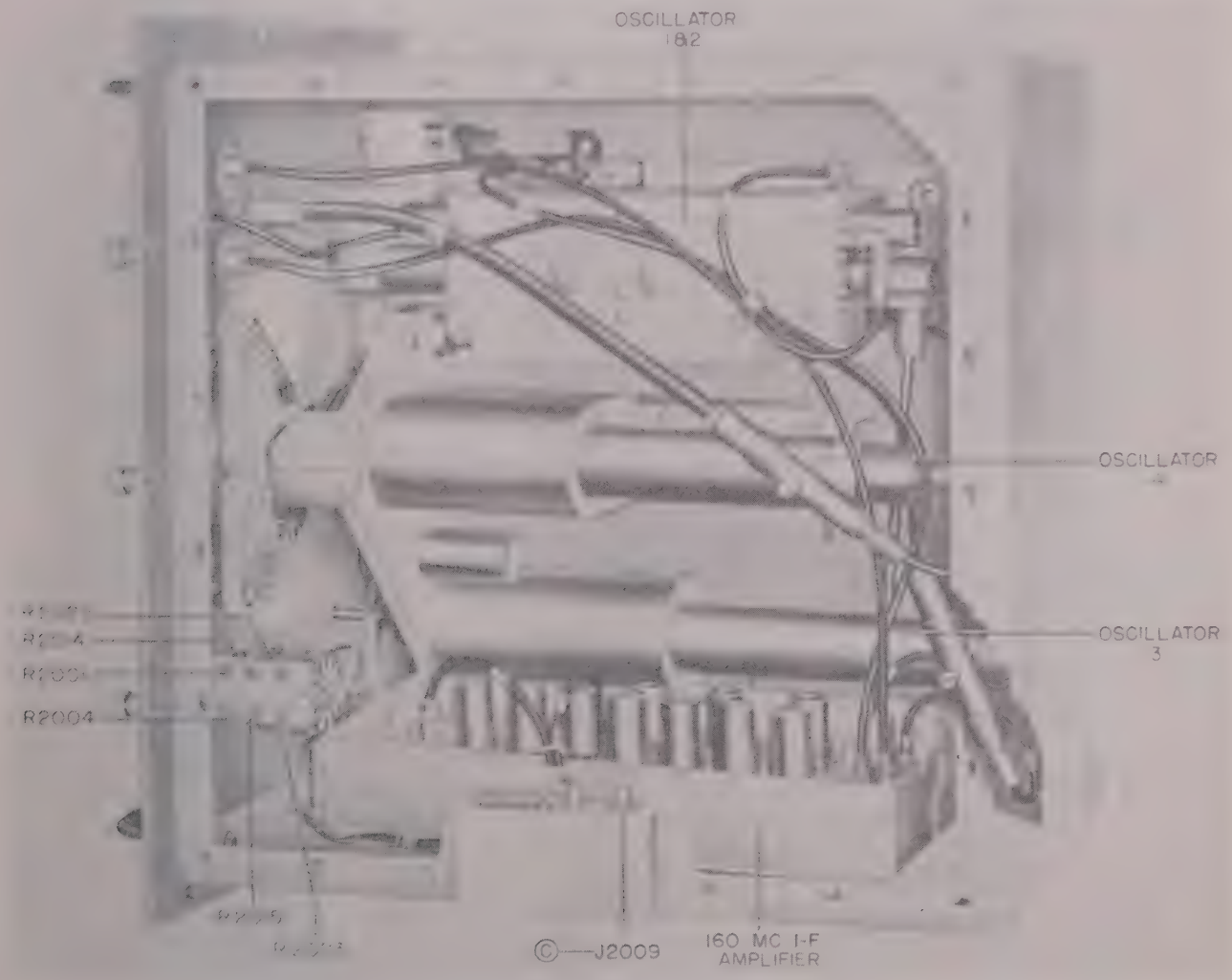


Figure 6-2. R-F Tuner, Top View

6-20. TUNER CALIBRATION. Check the tuner calibration by zero-beating frequency meter FR-6 (100-500 mc) or frequency meter FR-61 (500-2100 mc) against the spectrum analyzer for the appropriate settings of the "BAND SELECTOR" switch and "TUNE" control listed in table X. The tuning dial readings of the spectrum analyzer must be within one percent of the FR-6 or FR-61 frequency

NOTE

The FR-61 may be used below 500 mc by using harmonics. Oscillators 1, 2, and 3 oscillate 160 mc above the frequency being checked. Oscillator 4 oscillates 160 mc below the frequency being checked.

TABLE X. TUNER CALIBRATION

STEP	TEST POINT*	FR-6 SETTING	FR-61 SETTING	"BAND SELECTOR" SWITCH	"TUNE" CONTROL
1	1 (21, fig. 5-1)	170 mc		"10-150 MCS WIDE"	"10"
22	Same as step 1	200 mc		Same as step 1	"40"
3	Same as step 1	240 mc		Same as step 1	"80"
4	Same as step 1	280 mc		Same as step 1	"120"
5	Same as step 1	320 mc		Same as step 1	"160"
6	2 (20, fig. 5-1)	300 mc		"150-350 MCS"	"140"
7	Same as step 6	360 mc		Same as step 6	"200"
8	Same as step 6	410 mc		Same as step 6	"250"
9	Same as step 6	460 mc		Same as step 6	"300"
10	Same as step 6		510 mc	Same as step 6	"350"
11	3 (17, fig. 5-1)		510 mc	"350-1000 MCS"	"350"
12	Same as step 11		660 mc	Same as step 11	"500"
13	Same as step 11		710 mc	Same as step 11	"650"
14	Same as step 11		860 mc	Same as step 11	"700"
15	Same as step 11		1160 mc	Same as step 11	"1000"
16	4 (19, fig. 5-1)		790 mc	"1-2 KMCS"	"950"
17	Same as step 16		1040 mc	Same as step 16	"1200"
18	Same as step 16		1340 mc	Same as step 16	"1500"
19	Same as step 16		1640 mc	Same as step 16	"1800"
20	Same as step 16		1940 mc	Same as step 16	"2100"

* Connect the frequency meter to the test point.

6-21. OVERALL SENSITIVITY. Check the spectrum analyzer overall sensitivity by following the steps given in table XI through table XIV. The signal-to-noise ratio must be 2-to 1-cm deflection of signal on the scope screen for all the overall sensitivity checks.

TABLE XI. SENSITIVITY CHECK FOR BAND 10-150 MC*

STEP	TEST POINT	HEWLETT PACKARD MODEL 608 SETTING	"TUNE" CONTROL SETTING	SIGNAL GENERATOR ATTENUATOR READING
1	1 (21, fig. 5-1)	10 mc	"10"	Less than 150 uv.
2	Same as step 1	40 mc	"40"	Same as step 1
3	Same as step 1	80 mc	"80"	Same as step 1
4	Same as step 1	120 mc	"120"	Same as step 1
5	Same as step 1	160 mc	"160"	Same as step 1

* NOTE: Set "SPECTRUM WIDTH" knob (27, figure 5-1) to "1"; "BAND SELECTOR" switch (18, figure 5-1) to "10-150 MCS WIDE". Connect the Hewlett Packard Model 608 to the test point.

TABLE XII. SENSITIVITY CHECK FOR BAND 150-350 MC*

STEP	TEST POINT	HEWLETT PACKARD MODEL 608 SETTING	"TUNE CONTROL SETTING	SIGNAL GENERATOR ATTENUATOR READING
1	(2) (20, fig. 5-1)	140 mc	"140"	Less than 300 uv.
2	Same as step 1	200 mc	"200"	Same as step 1
3	Same as step 1	250 mc	"250"	Same as step 1
4	Same as step 1	300 mc	"300"	Same as step 1
5	Same as step 1	360 mc	"360"	Same as step 1

*NOTE: Set "SPECTRUM WIDTH" knob (27, figure 5-1) to "1"; "BAND SELECTOR" switch (18, figure 5-1) to "150-350 MCS". Connect the Hewlett Packard Model 608 to the test point.

TABLE XIII. SENSITIVITY CHECK FOR BAND 350-1000 MC*

STEP	TEST POINT	HEWLETT PACKARD MODEL 608 SETTING	TS-418	"TUNE" CONTROL SETTING	SIGNAL GENERATOR ATTENUATOR READING
1	(3) (17, fig. 5-1)	35 mc		"350"	Less than 600 uv.
2	Same as step 1	500 mc		"500"	Same as step 1
3	Same as step 1			"650"	Same as step 1
4	Same as step 1			"800"	Same as step 1
5	Same as step 1			"1000"	Same as step 1

*NOTE: Set the "SPECTRUM WIDTH" knob (27, figure 5-1) to "1"; "BAND SELECTOR" switch (18, figure 5-1) to "350-1000 MCS". Correct the Hewlett Packard Model 608 or TS-418 to the test point.

TABLE XIV. SENSITIVITY CHECK FOR BAND 1000-16,000 MC*

STEP	SIGNAL GENERATOR	GENERATOR SETTING	"BAND SELECTOR" SWITCH POSITION	"TUNE" CONTROL SETTING	***SIGNAL GENERATOR ATTENUATOR READING (dbm)
1	TS-419	950 mc	"1-2 KMCS"	"950"	50
2	TS-419	1200 mc	"1-2 KMCS"	"1200"	50
3	TS-419	1500 mc	"1-2 KMCS"	"1500"	50
4	TS-419	1600 mc	"1-2 KMCS"	"1600"	50
5	TS-419	2100 mc	"1-2 KMCS"	"2100"	50
6	TS-419	1700 mc	"2-4 KMCS"	"1700"	50
7	TS-419	2100 mc	"2-4 KMCS"	"2100"	50
8	Hewlett Packard Model 616A	2600 mc	"2-4 KMCS"	"2600"	50
9	Hewlett Packard Model 616A	3200 mc	"2-4 KMCS"	"3200"	50
10	Hewlett Packard Model 616A	4000 mc	"2-4 KMCS"	"4000"	50
11	Hewlett Packard Model 616A	3400 mc	"4-8 KMCS"	"3400"	40
12	**PRD Model 902	4400 mc	"4-8 KMCS"	"4400"	40
13	**PRD Model 902	5500 mc	"4-8 KMCS"	"5500"	40

TABLE XIV. SENSITIVITY CHECK FOR BAND 1000-16,000 MC* (cont)

STEP	SIGNAL GENERATOR	GENERATOR SETTING	"BAND SELECTOR" SWITCH POSITION	"TUNE" CONTROL SETTING	***SIGNAL GENERATOR ATTENUATOR READING (dbm)
13	**PRD Model 902	5500 mc	"4-8 KMCS"	"5500"	40
14	**PRD Model 902	6500 mc	"4-8 KMCS"	"6500"	40
15	**PRD Model 902	7000 mc	"4-8 KMCS"	"7000"	40
16	**PRD Model 902	6500 mc	"8-16 KMCS"	"6500"	40
17	Polarad Model MSG-4	7500 mc	"8-16 KMCS"	"7500"	40
18	Polarad Model MSG-4	8500 mc	"8-16 KMCS"	"8500"	40
19	Polarad Model MSG-4	9500 mc	"8-16 KMCS"	"9500"	40
20	Polarad Model MSG-4	10,000 mc	"8-16 KMCS"	"10,000"	40
21	Polarad Model SGX-12	12,500 mc	"8-16 KMCS"	"12,500"	40
22	Polarad Model SGX-12	13,000 mc	"8-16 KMCS"	"13,000"	40
23	Polarad Model SGX-12	13,500 mc	"8-16 KMCS"	"13,500"	40
24	Polarad Model SGX-12	14,000 mc	"8-16 KMCS"	"14,000"	40
25	Polarad Model SGX-12	14,500 mc	"8-16 KMCS"	"14,500"	40
26	Polarad Model SGX-12	15,000 mc	"8-16 KMCS"	"15,000"	40
27	Polarad Model SGX-12	15,500 mc	"8-16 KMCS"	"15,500"	40
28	Polarad Model SGX-12	16,000 mc	"8-16 KMCS"	"16,000"	40

NOTE: *Set the "SPECTRUM WIDTH" knob (27, figure 5-1) to "25"; Connect the signal generator to test point 4 (19, figure 5-1).
**Polytechnic Research and Development Company.
***Maximum input level.

6-22. SPURIOUS RESPONSES.

a. With no signal input, rotate the "TUNE" control (15, figure 5-1) throughout the dial range for all positions of the "BAND SELECTOR" switch ("10-150 MCS NARROW," "10-150 MCS WIDE," "150-350 MCS," "350-1000 MCS," "1-2 KMCS," "2-4 KMCS," "4-8 KMCS," and " 8-16 KMCS").

b. Any spurious response, throughout step a, must not be more than twice the amount of the noise level.

6-23. TROUBLE ANALYSIS.

6-24. Table XV is an aid in locating troubles that might occur in the spectrum analyzer. It lists probable causes, and the remedies to be performed by field maintenance personnel.

TABLE XV. TROUBLE SHOOTING CHART

TROUBLE	PROBABLE CAUSE	REMEDY
B supply voltage low.	Low input power.	Check power source.
	T1301 defective.	Replace.
	V1308, V1309, V1310 V1311, or V1312 defective.	Check for defective tube and replace.
Analyzer does not operate in the "10-150 MCS NARROW" position. Operation is normal in all other positions.	Narrow band i-f amplifier V2201, V2202, V2203, and V2204 defective.	Check for defective tube and replace.
	S2001 or S2201 defective.	Clean contacts or replace switch as necessary.
Analyzer does not operate above 1000 mc. Operation is normal below 1000 mc.	Oscillator 4 defective.	Replace cavity.
	S2001 or S2201 defective.	Clean contacts or replace switch as necessary.
Analyzer does not operate in the "350-100 MCS" position. Operation is normal in all other positions.	Oscillator 3 defective.	Replace cavity.
	S2001 or S2201 defective.	Clean contacts or replace switch as necessary.
Analyzer does not operate in the "150-350" MCS" position. Operation is normal in all other positions.	V2501 or V2502 defective.	Check for defective tube and replace.
	S2001 or S2201 defective.	Clean contacts or replace switch as necessary.
Analyzer does not operate in the "10-150 MCS NARROW" and the "10-150 MCS WIDE" positions. Operation is normal in all other positions.	V2503 or V2504 defective.	Clean contacts or replace switch as necessary.
	S2001 or S2201 defective.	Clean contacts or replace switch as necessary.
Analyzer operates normally in the "10-150 MCS NARROW" position, but does not operate in all other positions.	Wide band amplifier V2201, V2202, V2203, or V2204 defective.	Check for defective tube and replace.
No output from the spectrum calibration.	V1401 defective.	Replace.
No vertical sweep on the scope screen. The video input from the 1-mc i-f is normal.	V1304, V1305, or V1307 defective.	Check for defective tube and replace.
No horizontal sweep.	V1301, V1302, or V1303 defective.	Check for defective tube and replace.
Pattern cannot be synchronized.	V1301, V1302, or V1303 defective	Check for defective tube and replace.
	Sweep frequency generator V1501, V1502, V1503, V1504 V1505, or V1506 defective.	Check for defective tube and replace.
Cannot control the brightness.	KRT defective.	Replace.
	R1004 defective.	Replace.
	C1003 defective.	Replace.
No pattern on the scope screen.	High voltage power supply defective.	Replace.
	KRT defective.	Replace.

6-25. REMOVAL AND REPLACEMENT. Replace defective parts with the same type replacement parts. After replacing any electronic parts in any subassembly, the associated circuit should be checked for its minimum performance standard, as listed in paragraphs 6-3 through 6-22, to insure proper operation of the analyzer. If any of the minimum performance standards are not obtained, the associated subassembly must be replaced. Repairs to the individual subassemblies should not be attempted at this level of maintenance. Detailed maintenance of the individual subassemblies are covered in the latest issue of the Handbook of Overhaul Instructions.

6-26. VOLTAGE AND RESISTANCE MEASUREMENTS. Listed in table XVI through XXV are voltage and resistance measurements for the spectrum analyzer. All measurements are made with a Simpson Model 260 Multitester from test point to ground. Any appreciable variation in voltage, and/or resistance from the specified values, indicates a probable malfunction. The causes for any such variation should be traced and repaired to insure proper operation of the spectrum analyzer.

WARNING

The high voltage employed in this equipment is dangerous to human life. Use extreme caution when making voltage checks. Maintenance personnel must at all times observe all safety precautions.

NOTE

All resistance measurements must be made with the equipment turned off, and with the tube removed from the socket being measured.

TABLE XVI. 1-MC I-F AMPLIFIER VOLTAGE AND RESISTANCE MEASUREMENTS

CIRCUIT SYMBOL		PIN NUMBER 1	2	3	4	5	6	7	8	9
V1201	V	148	-6.4	0	6.3**	6.3**	148	-0.1	0	0
	R	28K	47K	0.2	Heater	Heater	28K	10K	0	0
V1202	V	1.4	5.3	0	6.3**	148	131	0		
	R	330	1.1K	0	Heater	28K	35K	47K		
V1203	V	0	2.8	6.3**	0	148	148	2.8		
	R	510K	∞	Heater	0	28K	28K	930		
V1204	V	127	5.1	12	0	0	0.7	12	12	6.3**
	R	38K	102K	2.8K	0	0	37K	510K	2.8K	Heater
V1205	V	-3.3	0	0	6.3**	148	83	0		
	R	57K	0	0	Heater	38K	15K	0		
V1206	V	-2.6	0	0	6.3**	148	83	0		
	R	74K	0	0	Heater	38K	15K	0		
TP1201	V	0								
	R	470K								

NOTE: *Will vary setting of R1229.
**A-C volts.

TABLE XVII. 64-MC I-F AMPLIFIER VOLTAGE AND RESISTANCE MEASUREMENTS

CIRCUIT SYMBOL		PIN NUMBERS 1	2	3	4	5	6	7
V1101	V	50	-1	0	6.3**	0.4	-1	50
	R	∞	47K	Heater	Heater	390	∞	∞
V1102	V	-0.1	0.42*	6.3**	0	148	80	0.42
	R	330K	∞	Heater	0	∞	∞	51
V1103	V	0	6.3	6.3**	0	148	131	6.3
	R	330K	∞	Heater	0	∞	∞	10K*
V1104	V	0	4.9	6.3**	0	148	137	4.9
	R	330K	∞	Heater	0	∞	∞	4.7K
V1105	V	0	1.85	6.3**	0	148	103	1.85
	R	330K	∞	Heater	0	∞	∞	220

NOTE: * Will vary with setting of R1112
**A-C volts

TABLE XVIII. SWEEP FREQUENCY GENERATOR VOLTAGE AND RESISTANCE MEASUREMENTS

CIRCUIT SYMBOL		PIN NUMBERS 1	2	3	4	5	6	7	8	9
V1501	V	-4.5	0	6.3**	0	136	143	0		
	R	47K	0	Heater	0	∞	∞	0		
V1502	V	135	-0.25	0	0	0	139	-0.27	0	6.3**
	R	∞	15K	0.2	0	0	∞	22K	0.2	Heater
V1503	V	0	0	6.3**	0	147	147	1.6		
	R	12K	0	Heater	0	∞	∞	120		
V1504	V	0	0	6.3**	0	147	147	1.7		
	R	2.7K	0	Heater	0	∞	∞	120		
V1505	V	-1.5	1.5	6.3**	0	147	88	1.4		
	R	5.1K	∞	Heater	0	∞	∞	51		
V1506	V	-3.5	0	6.3**	0	147	140	0		
	R	10K	0	Heater	0	∞	∞	0		
TP1501*	V	1.8								
	R	100K								
TP1502*	V	0.7								
	R	87K								
TP1503*	V	0.3								
	R	47K								
TP1504	V	0								
	R	0								
TP1505	V	0								
	R	0								
TP1506	V	-4.5								
	R	10K								

NOTE: * Diode involved
**A-C volts

TABLE XIX. POWER SUPPLY AND VIDEO VOLTAGE AND RESISTANCE MEASUREMENTS

CIRCUIT SYMBOL		PIN NUMBERS 1	2	3	4	5	6	7	8	9
*V1301	V	31	-138	-142	6.3**	6.3**	-150	-170	-142	0
	R	8.5K	510K	48K	100	100	82K	3MEG	48K	∞
V1302	V	-90	-170	-150	6.3**	6.3**	15	-140	-135	0
	R	2.5MEG	2.5MEG	48K	100	100	100K	62K	51K	∞
V1303	V	77	-140	-137	6.3**	6.3**	-28.5	-137	-137	0
	R	530K	52K	70K	100	100	530K	70K	68K	∞
V1304	V	115	0	1.25	6.3**	6.3**	0	0	0	0
	R	85K	0	510	100	100	0	0	0	∞
V1305	V	85K	0	510	100	100	0	0	0	0
	R	200K	1-1/2MEG	63K	110	100	290K	70K	63K	∞
V1306	V	-0.35	0	6.3**	0	147	30	0		
	R	2.2MEG	0	100	100	75K	530K	0		
V1307	V	-144	-144	-120	6.3**	6.3**	110	0	1.9	0
	R	50K	50K	1.1MEG	100	100	75K	1MEG	220	∞
V1308	V	-32	77	0	107	260	150	0	6.3**	
	R	1MEG	50K	0	1MEG	75K	75K	100	100	
V1309	V	-32	-65	-65	6.3**	6.3**	-65	-87	-87	
	R	1MEG	560K	33K	100	100	560K	84K	40K	∞
V1310	V	0	0	0	-87	0	0	0		
	R	0	∞	∞	40K	∞	∞	∞		
V1311	V	107	260	150	107	260	150	0	6.3**	
	R	1MEG	78K	70K	1MEG	75K	70K	100	100	
V1312	V	110	52	52	6.3**	6.3**	52	-0.35	0	0
	R	1.1MEG	120K	300K	100	100	300K	110K	0	∞
TP1301	V	150								
	R	70K								
TP1302	V	-150								
	R	48K								

NOTE: * All front panel controls are fully counterclockwise
**A-C volts

TABLE XX. SPECTRUM CALIBRATOR AND KRT VOLTAGE AND RESISTANCE MEASUREMENTS

CIRCUIT SYMBOL		PIN NUMBERS 1	2	3	4	5	6	7	8	9	10	11	14
V1401	V	150	-1.115*	1.05*	0	0	150	-2.0*	1.05*	6**			
	R	∞	10K	110	0	0	∞	10K	110	∞			
V1001	V												
	R	3.5MEG	3.5MEG	5MEG		3.5MEG		∞	∞	∞	∞	∞	∞

NOTE: * Will vary with setting of "FREQUENCY" knob
**A-C volts

TABLE XXI. HIGH VOLTAGE SUPPLY AND RESISTANCE MEASUREMENTS

CIRCUIT SYMBOL		A	B	C
TP1601	V	158		
	R	5MEG		
TP1602	V	-160		
	R	5MEG		
J1601	V			
	R	0	∞	∞
J1602	V			
	R	∞		
J1603	V			
	R	∞		
J1604	V			
	R	7MEG		
P1601	V			
	R	6MEG		

TABLE XXII. OSCILLATORS 1 AND 2 VOLTAGE AND RESISTANCE MEASUREMENTS

CIRCUIT SYMBOL		PIN NUMBERS 1	2	3	4	5	6	7	8	9
V2601	V									
	R	∞	8820	0	0	620	8820	∞		
V2505	V									
	R	∞	0	0	0	441	0	∞		
V2503	V									
	R	∞	47K	0	0	0	∞	47K	0	0
V2504	V									
	R	∞	0	0	0	150	0	∞		

TABLE XXIII. 160-MC I-F AMPLIFIER VOLTAGE AND RESISTANCE MEASUREMENTS

CIRCUIT SYMBOL		PIN NUMBERS 1	2	3	4	5	6	7
V2201**	V	0	0.4	6*	0	147	75	0.4
	R	0	∞	0.6	0	∞	∞	∞
V2202**	V	0	1.3	6*	0	137	100	1.3
	R	0	∞	0.6	0	∞	∞	∞
V2203**	V	0	1.3	6*	0	133	105	1.3
	R	0	∞	0.6	0	∞	∞	∞
V2204**	V	0	1.3	6*	0	137	107	1.3
	R	0	∞	0.6	0	∞	∞	∞
V2205**	V	0	1.5	6*	0	145	115	1.5
	R	0	100	0.6	0	∞	∞	100
V2206**	V	0	1.5	6*	0	120	115	1.5
	R	0	100	0.6	0	∞	∞	∞
C2207**	V	0	0.95	6*	0	150	115	0.95
	R	0	68	0.6	0	∞	∞	68
V2208***	V	0	0.5	6*	0	150	70	0.5
	R	51	∞	0.6	0	∞	∞	∞
V2209***	V	0	4.0	6*	0	150	125	4.0
	R	0	∞	0.6	0	∞	∞	∞
V2210***	V	0	4.0	6*	0	145	130	4.0
	R	0	∞	0.6	0	∞	∞	∞

NOTE: * A-C volts
** Range Selector switch in any position except the "10-150 MCS NARROW" position
***Range Selector switch in the "10-150 MCS NARROW" position

TABLE XXIV. CONNECTORS, RESISTANCE MEASUREMENTS

CIRCUIT SYMBOL	LOCATION	PIN NUMBERS A 1	B 2	C 3	D 4	E 5	F 6	G 7	H 8	I 9	J 10	K 11	L 12	M 13	N 14	O 15
J1001	Indicator															
	Drawer	∞	∞		0	∞		∞	∞		∞	∞	∞			
J1002	Indicator															
	Drawer	∞		∞	0	∞		200K		∞	80K	∞		∞	∞	∞
J1004	Indicator															
	Drawer				0			200K			80K			∞	∞	
J1005	Indicator															
	Drawer				0			200K						∞	∞	
J1006	Indicator															
	Drawer				0			200K	∞			∞		∞		∞
J1008	Indicator															
	Drawer				0			200K			70K			∞		∞
J1003	Indicator															
	Drawer		0	∞	80K	∞	200K		∞							
P1005	Indicator															
	Drawer	0	∞	∞												
J1601	High Voltage															
	Supply	0	∞	∞												

TABLE XXIV. CONNECTORS, RESISTANCE MEASUREMENTS (cont)

CIRCUIT SYMBOL	LOCATION	PIN NUMBERS A 1	B 2	C 3	D 4	E 5	F 6	G 7	H 8	I 9	J 10	K 11	L 12	M 13	N 14	O 15
J1602	High Voltage Supply	∞														
J1603	High Voltage Supply	∞														
J1604	High Voltage Supply	7MEG														
P1601	High Voltage Supply	6MEG														
P1201	1-MC I-F Amplifier				0			28K			350K			0	HTR	
P1102	64-MC I-F Amplifier				0			∞						0	HTR	
P1502	Sweep Freq. Generator				0			∞			1MEG			0		HTR
P1301	Power Supply & Video	∞		∞	0	100		70K		100	48K	100		100	100	100
P1302	Power Supply & Video	530K	530K		0	82K		70K	70K		48K	290K	290K			
P2201	160-MC I-F Amplifier	∞		∞	0			∞		∞		∞		∞	HTR	
P1401	Spectrum Calibrator				0			∞		∞		∞		0		∞
J1401	Spectrum Calibrator	1358														
J2011	R-F Tuner Drawer	∞	0	0	∞	0	∞		0							
J2501	Oscillators 1 and 2	∞	0	0	∞	0	∞		∞							
J2504	Oscillators 1 and 2	∞														
J2505	Oscillators 1 and 2	∞														
J2503	Oscillators 1 and 2	∞														

TABLE XXV. 160-MC I-F AMPLIFIER INPUT JACKS, RESISTANCE MEASUREMENTS

CIRCUIT SYMBOL	* SWITCH S2201 POSITIONS 1	2	3	4	5	6	7	8
J2201	∞	∞	∞	∞	∞	∞	0	∞
J2202	∞	∞	∞	∞	∞	0	∞	∞
J2203	∞	∞	∞	∞	0	∞	∞	∞
J2204	0	0	0	0	∞	∞	∞	∞

NOTE: *Starting with position 1 as the maximum counterclockwise position.

6-27. ALIGNMENT AND ADJUSTMENTS. The alignment and adjustment procedures for the spectrum analyzer are listed in paragraphs 6-3 through 6-22. For more detailed alignment procedures refer to the latest issue of the Handbook of Overhaul Instructions.

6-28. LUBRICATION. Lubrication is usually unnecessary. However, if excessive dirt or dryness might hinder the operation of the gear train assembly and lead screws, the following procedure should be performed.

a. Clean gear train assembly and lead screws with a typewriter brush.

b. Using Aeroshell Grease 7 (MIL-G-7118) on a clean fingertip, wipe the gear train assembly and lead screws lightly.

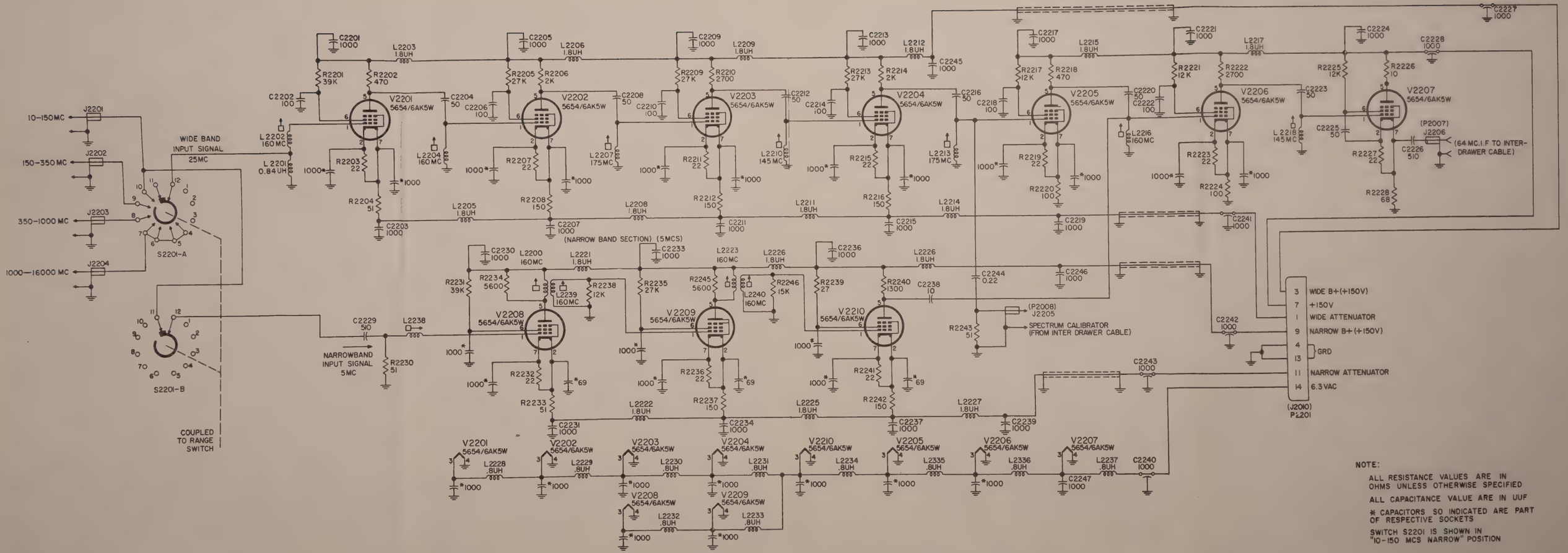
SECTION VII

DIAGRAMS

7-1. GENERAL. The following diagrams are used for maintenance of the spectrum analyzer. Each diagram is located by its corresponding title and figure number which is listed in paragraph 7-2. Any specific notes are contained on the particular diagram.

7-2. INDEX OF DIAGRAMS. The following is a list of diagrams contained on the following pages:

Figure	Title	Page
7-1.	160-MC I-F Amplifier Schematic Diagram	53/54
7-2.	Spectrum Calibrator Schematic Diagram	55/56
7-3.	64-MC I-F Amplifier Schematic Diagram	57
7-4.	1-MC I-F Amplifier Schematic Diagram	58
7-5.	Sweep Frequency Generator Schematic Diagram	59
7-6.	Power Supply and Video Schematic Diagram	60
7-7.	Oscillator 3 Schematic Diagram	61
7-8.	High Voltage Power Supply Schematic Diagram	61



NOTE:

ALL RESISTANCE VALUES ARE IN OHMS UNLESS OTHERWISE SPECIFIED

ALL CAPACITANCE VALUE ARE IN UUF

* CAPACITORS SO INDICATED ARE PART OF RESPECTIVE SOCKETS

SWITCH S2201 IS SHOWN IN "10-150 MCS NARROW" POSITION

Figure 7-1. 160 MC I-F Amplifier Schematic Diagram

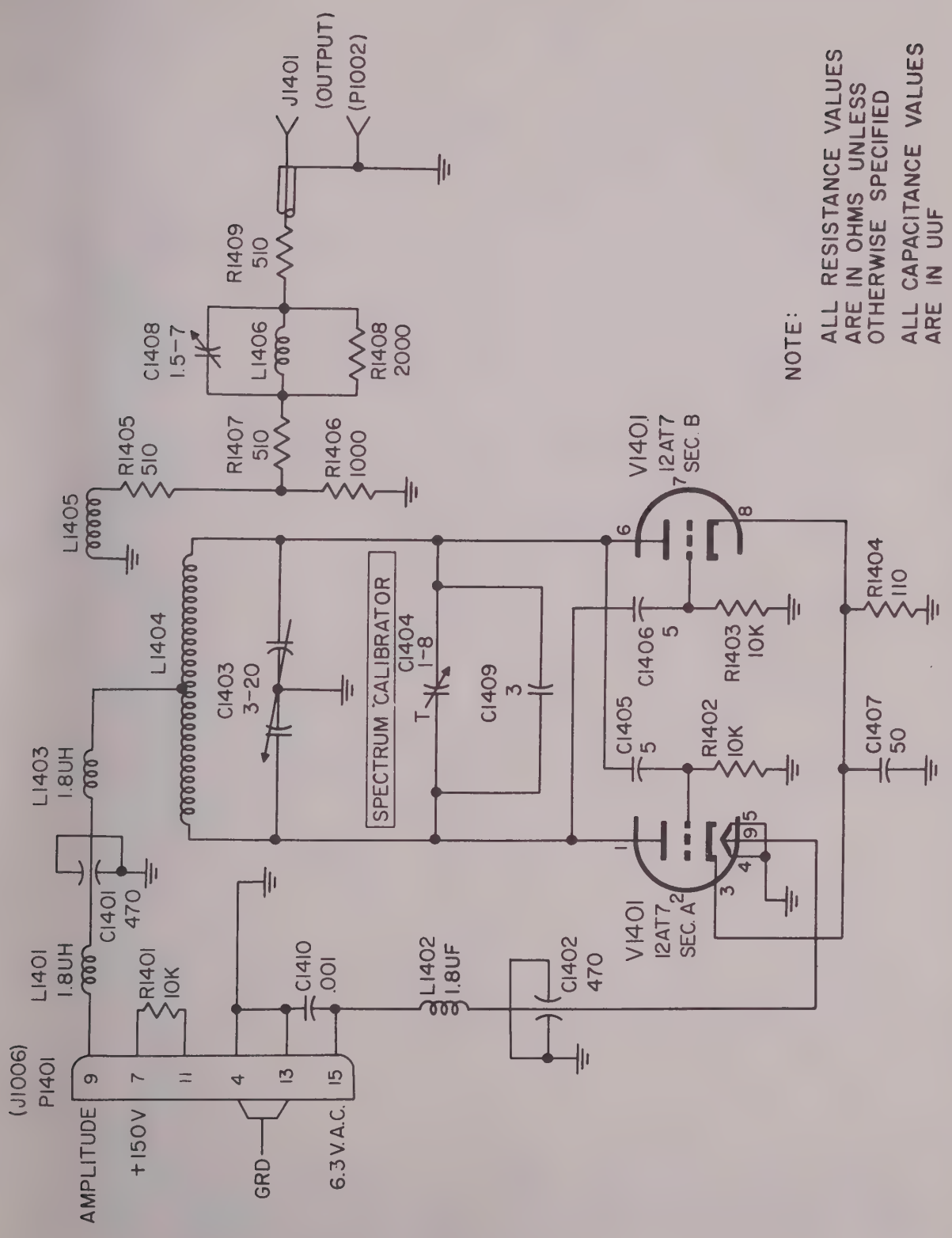
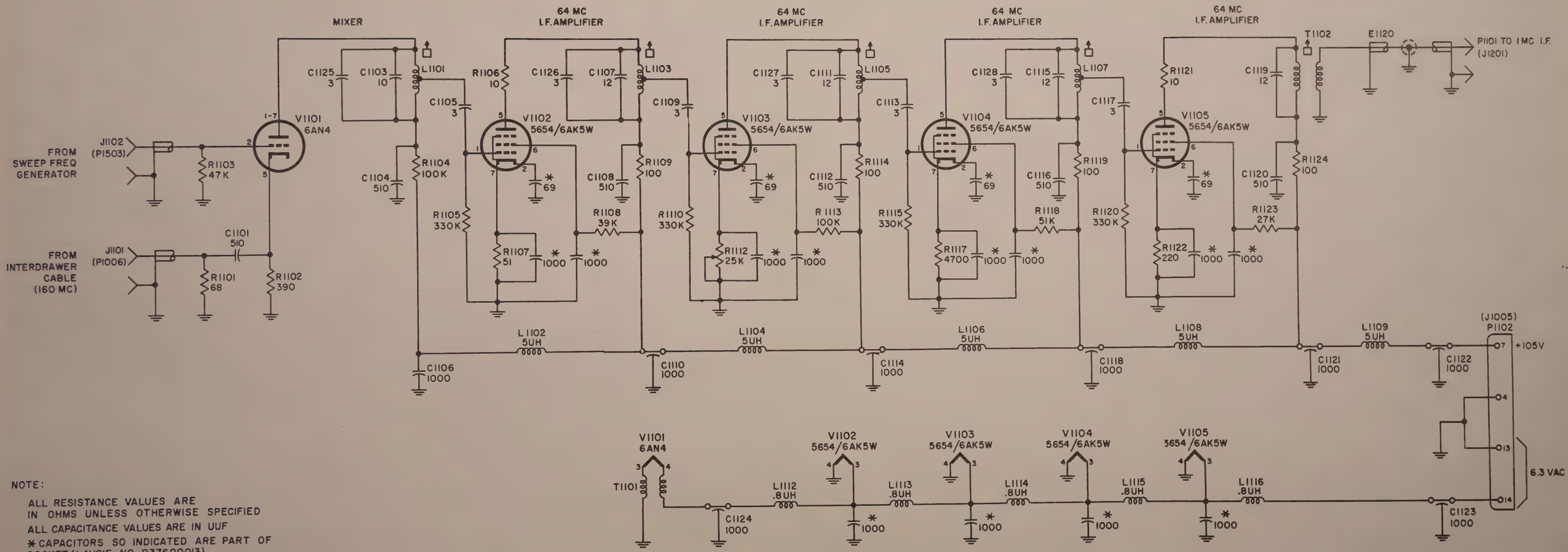


Figure 7-2. Spectrum Calibrator Schematic Diagram



NOTE:

ALL RESISTANCE VALUES ARE IN OHMS UNLESS OTHERWISE SPECIFIED

ALL CAPACITANCE VALUES ARE IN UUF

* CAPACITORS SO INDICATED ARE PART OF SOCKET (LAVOIE NO. P37600013)

Figure 7-3. 64-MC I-F Amplifier Schematic Diagram

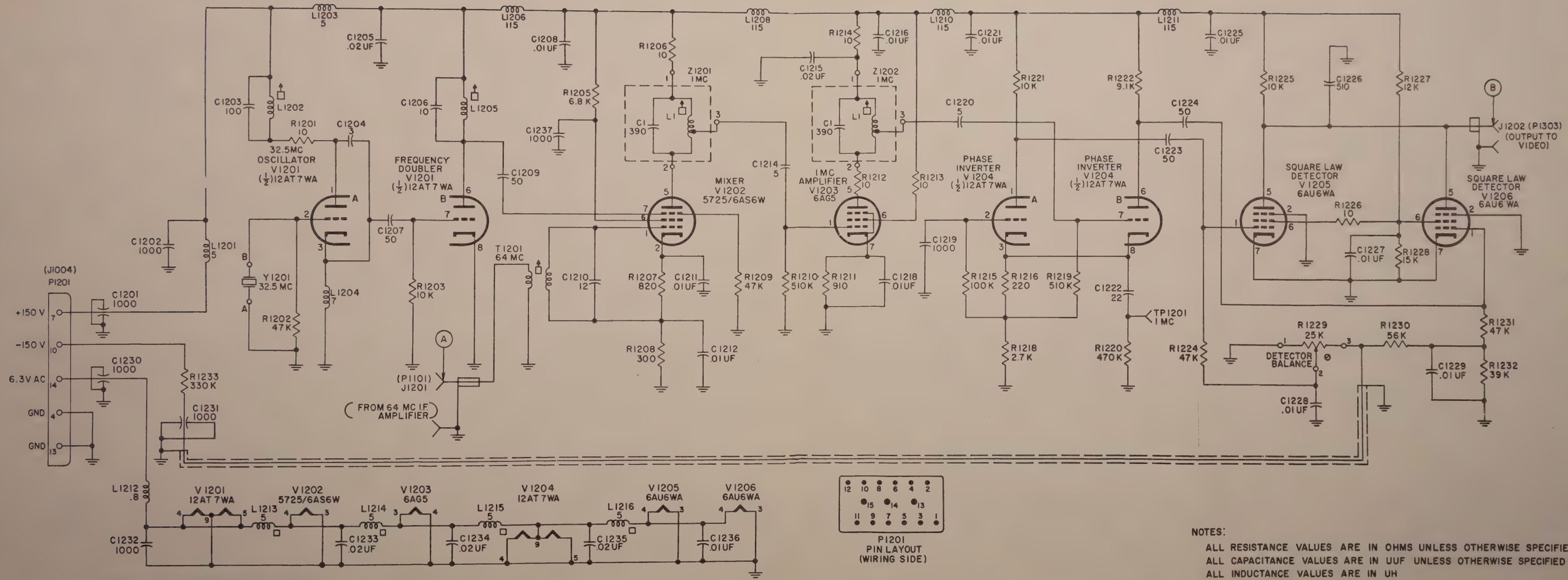
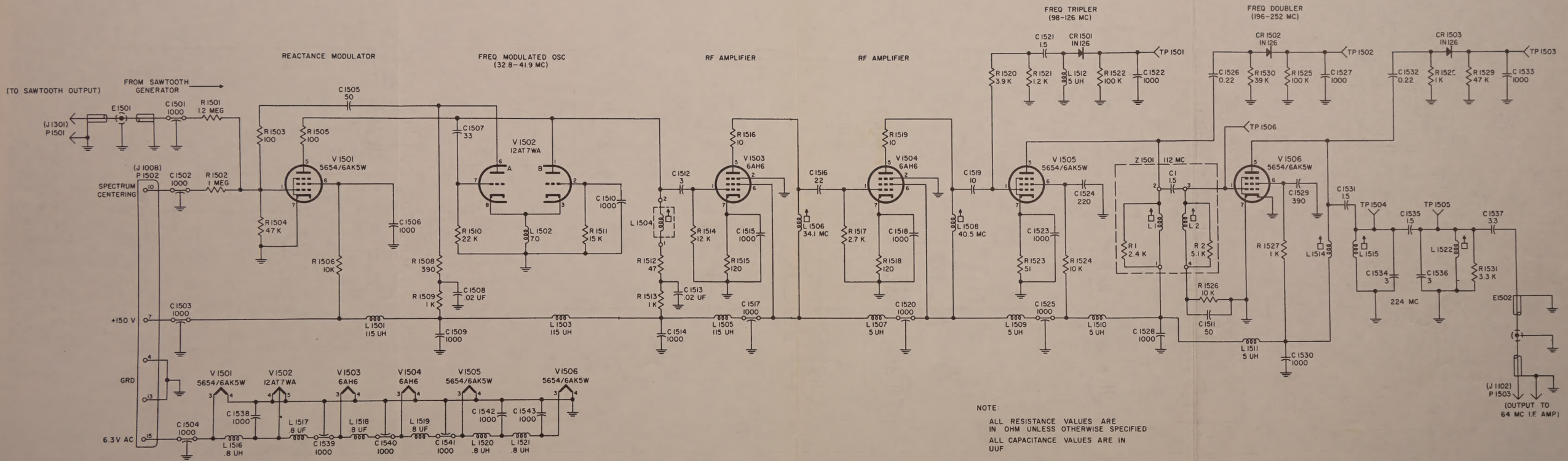


Figure 7-4. 1-MC I-F Amplifier, Schematic Diagram

NOTES:

ALL RESISTANCE VALUES ARE IN OHMS UNLESS OTHERWISE SPECIFIED
ALL CAPACITANCE VALUES ARE IN UUF UNLESS OTHERWISE SPECIFIED
ALL INDUCTANCE VALUES ARE IN UH

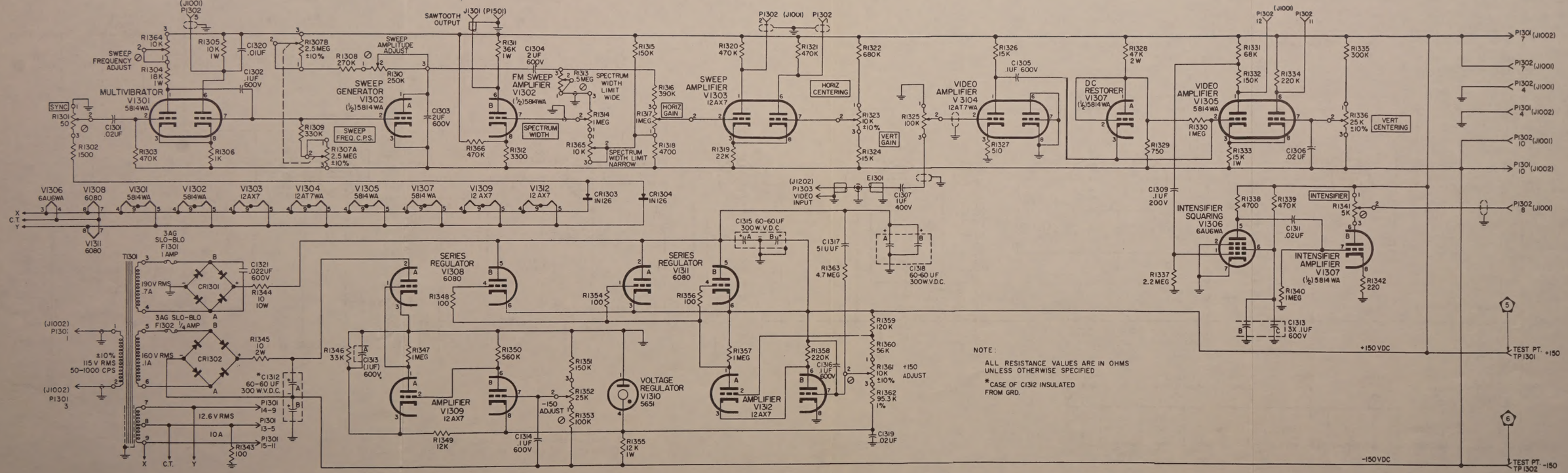


NOTE:

ALL RESISTANCE VALUES ARE IN OHM UNLESS OTHERWISE SPECIFIED

ALL CAPACITANCE VALUES ARE IN UUF

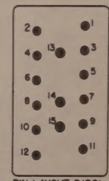
Figure 7-5. Sweep Frequency Generator, Schematic Diagram



NOTE:

ALL RESISTANCE VALUES ARE IN OHMS UNLESS OTHERWISE SPECIFIED

*CASE OF C1312 INSULATED FROM GRD.



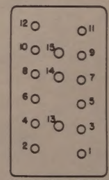


Figure 7-6. Power Supply and Video, Schematic Diagram

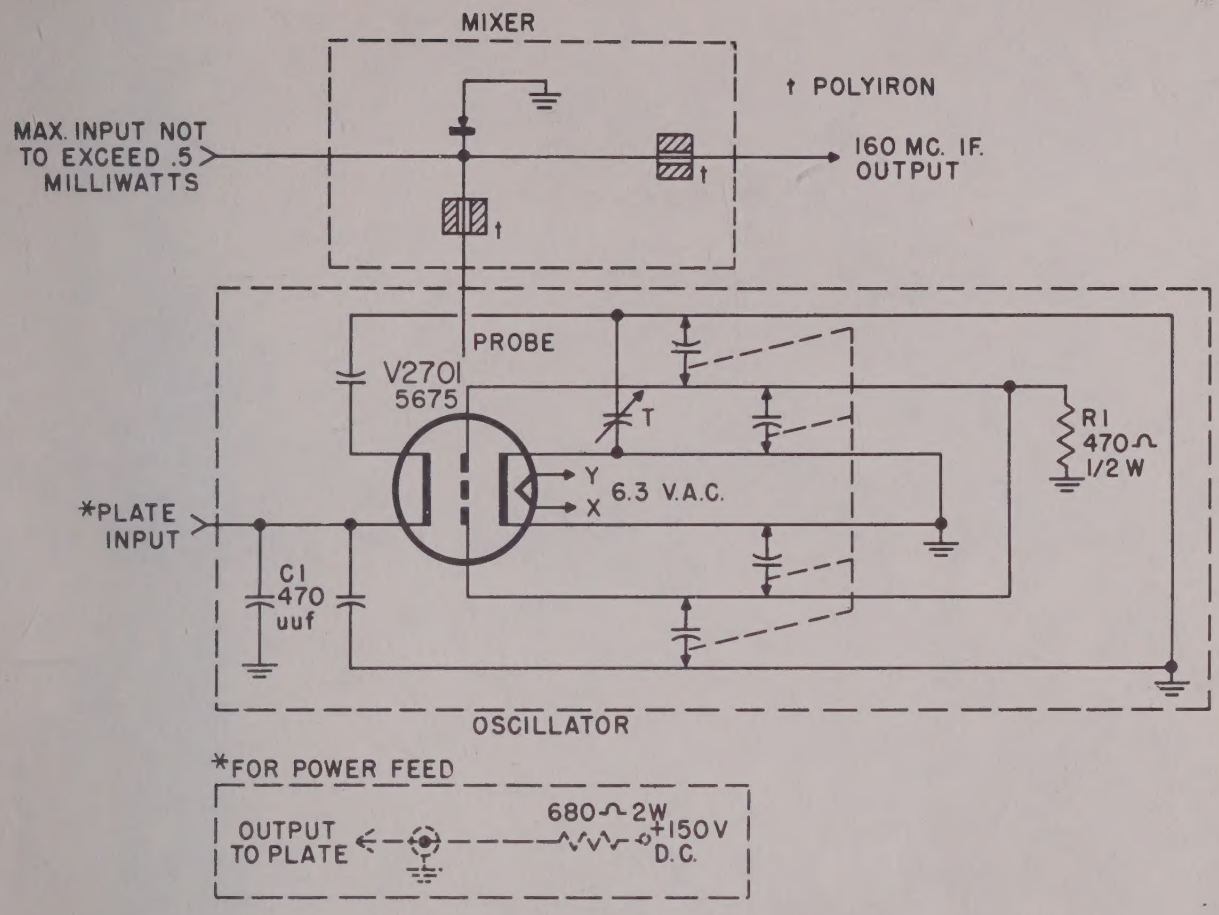


Figure 7-7. Oscillator 3, Schematic Diagram

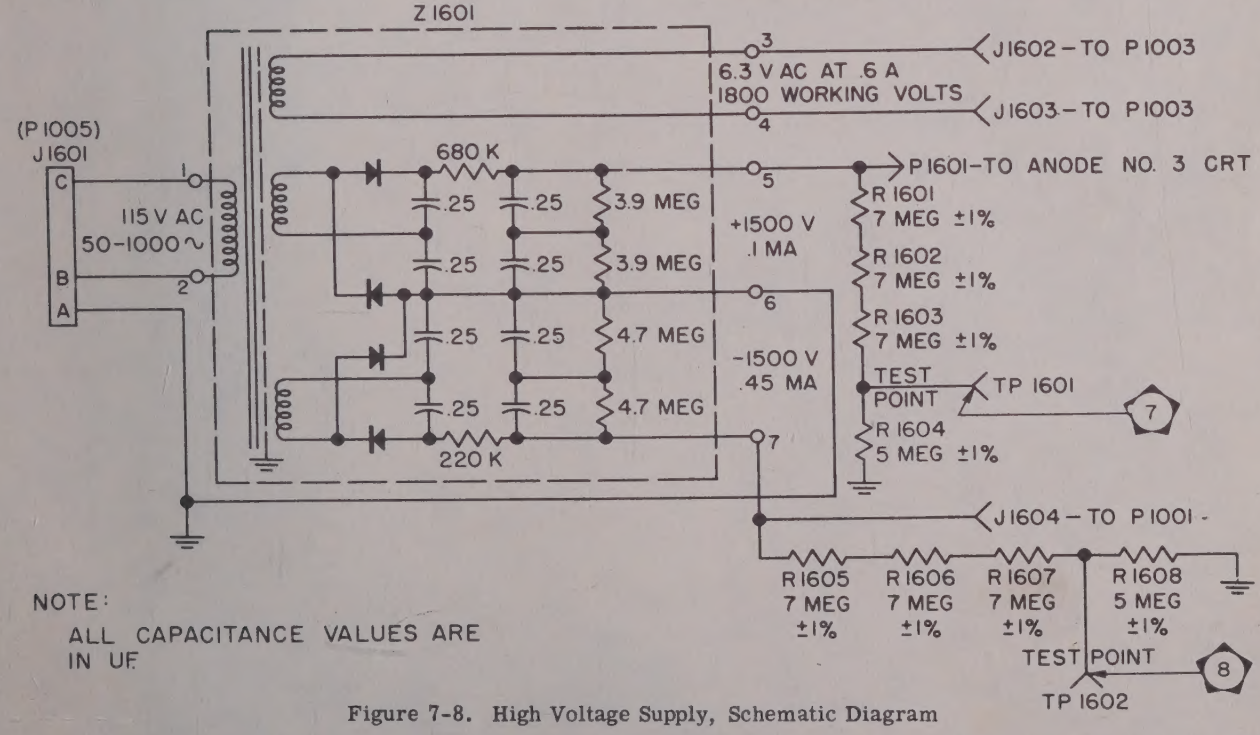


Figure 7-8. High Voltage Supply, Schematic Diagram

SECTION VIII

DIFFERENCE DATA SHEETS

Not applicable.